

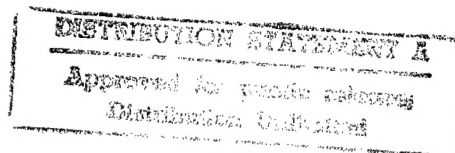
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14 March 1986

# USSR Report

MATERIALS SCIENCE AND METALLURGY



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14 March 1986

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MATERIALS SCIENCE AND METALLURGY

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COULOMETRIC DETERMINATION OF GOLD IN Au-Pt ALLOYS AT MONITORED POTENTIAL

Moscow ZAVODSKAYA LABORATORIYA in Russian Vol 51, No 9, Sep 85  
(manuscript received 19 Jul 84) pp 1-3

BEDRIN, L. D. and OGANESYAN, L. B., Moscow Chemical Technology Institute  
imeni D. I. Mendeleyev

[Abstract] A coulometric method of determining gold in Au-Pt alloys is outlined, a method which involves monitoring the potential and plotting polarization curves. A platinum electrode with a surface area of  $1 \text{ cm}^2$  is used for plotting the polarization curves with a P-5827 potentiometer. The gold content is measured with a platinum-mesh cathode having a surface area of  $56 \text{ cm}^2$  and a platinum-wire anode in a separate compartment containing aqueous  $1 \text{ M H}_2\text{SO}_4$  solution, with an AgCl reference electrode. Polarization curves plotted by this procedure include a reduction wave with a wide peak-current plateau for gold and without such a plateau for platinum. The supporting electrolyte ( $\text{HCl}:\text{HNO}_3 = 3:1$ ) is preelectrolyzed to the residual-current level. Gold is electrically reduced at the same potential to the residual-current level. The electric charge is recorded over a period of approximately 15 min with the aid of an integrator. Since both gold and platinum ions become reduced within the same potential range, alkali and ammonium-buffer supporting electrolytes are unsuitable for determination of gold in the presence of platinum by the method of potentiostatic coulometry. The method yields results reproducible with a variance coefficient of 0.004; in three alloys tested it has yielded  $74.9 \pm 0.13\%$ ,  $90.0 \pm 0.15\%$ ,  $95 \pm 0.15\%$  Au respectively.

References 3: all Western.

[44-2415/12955]



## THERMOMETRIC DETERMINATION OF SILVER IN PRESENCE OF IRON AND NONFERROUS METALS

Moscow ZAVODSKAYA LABORATORIYA in Russian Vol 51, No 9, Sep 85  
(manuscript received 13 Feb 84) pp 3-4

GUSEV, V. I., BURYLEV, B. P. and GUSAROV, A. A., Kuban State University,  
Krasnodar

[Abstract] An experimental study of reaction involving potassium hexacyano-ferrate and nitrates of various metals (Fe, Co, Ni, Cu, Ag) in pure or mixed solutions has established the feasibility of determining silver thermometrically, with a glass calorimeter based on the Christensen calorimeter and with a thermistor (K-17, 4 kohm at 20°C) in one arm of a Wheatstone bridge. The validity of this method is based on the thermodynamics of titration, nitrates of silver and of the likely companion metals having been titrated in the experiment with ferrocyanide fed into the calorimeter by a micropump. The method was used first for determination of silver in binary mixtures containing also Cu, Ni, Co, or Fe and then for determination of silver in various silver solders. It can be used for determination of silver in alloys of other non-ferrous metals and also for detection of nitric acid in such materials.

References 6: 2 Russian, 4 Western.

[44-2415/12955]

## USE OF NUCLEAR-GAMMA RESONANCE METHOD FOR NONDESTRUCTIVE QUICK HEAT-TREATMENT INSPECTION OF CUTTING TOOL MADE OF HIGH-SPEED STEEL

Moscow ZAVODSKAYA LABORATORIYA in Russian Vol 51, No 9, Sep 85  
(manuscript received 7 Jan 85) pp 33-34

ALEKSEYEV, L. A. and SHAMOV, A. I., All-Union Scientific Research Institute  
for Tools

[Abstract] The feasibility of using nuclear-gamma resonance for nondestructive quick heat-treatment inspection of cutting tools made of high-speed steel is established theoretically, on the basis of changes in the NGR spectrum of steel resulting changes in the phase composition caused by heat treatment. Considering that the ratio of paramagnetic phases (austenite+ carbides) to ferromagnetic phases (martensite) depends on the heat treatment process mode and temperatures, the criterion selected is the ratio of thermal effects  $\epsilon(0)/\epsilon(V)$ ,  $\epsilon(0)$  - in the null channel and  $\epsilon(V) [N(00) - N(V)]/N(00)$ ,  $N(V)$  - count rate at corresponding speed, assuming the same value of the Lamb-Mössbauer coefficient for all phases. In this way it is possible to monitor the correct quenching temperature, tempering temperature, and number of tempers. References 3: 2 Russian, 1 Western.

[44-2415/12955]

## METHOD OF ELECTROPLASTIC DEFORMATION OF METAL

Moscow ZAVODSKAYA LABORATORIYA in Russian Vol 51, No 9, Sep 85  
(manuscript received 20 Jun 84) pp 57-60

TROITSKIY, O. A. and MOISEYENKO, M. M, Institute of Physical Chemistry,  
USSR Academy of Sciences, Moscow

[Abstract] A method of electroplastic deformation of a metal is proposed which eliminates strain hardening and involves sending pulse trains through the specimen rather than single pulses of electric current. Active deformation in tension or compression at a constant rate is periodically discontinued and, while the load remains applied at the constant level, a train of electric current pulses is sent through the specimen. The resulting plastic deformation decreases the mechanical stress, first appreciably and then in smaller decrements to an eventually constant level. The load is then increased by 5-10% and the process is repeated. Each pulse train consists of at least 20 current pulses of at least 40  $\mu$ s duration and 800 A/mm<sup>2</sup> amplitude, repeated at a rate of 0.5 Hz. The method was experimentally tried on zinc crystals of 99.998% purity, 16 mm long and 1 mm in diameter with welded-on caps and copper leads for loading in the test fixture and for feeding electric current respectively. The specimens were loaded in tension, with a dynamometer stiffness of  $1.2 \cdot 10^4$  N/m and at a strain rate of  $8 \cdot 10^{-3}$  s<sup>-1</sup>. Tests were performed at ambient temperatures of 78 K in liquid nitrogen and 273 K in water with thawing ice. The results reveal that the maximum stress decrement occurs during the initial relaxation by the very first electric pulse train. The stress decrement decreases with increasing number of pulse trains, but increases with increasing pulse duration. As the latter was lengthened by a factor of 5 from 40  $\mu$ s to 200  $\mu$ s, the total stress decrement after 5 pulse trains was 12 times larger than after relaxation without electric current. The dependence of stress decrement on initial stress level follows similar trends at various strain rates, in this case from  $8 \cdot 10^{-3}$  s<sup>-1</sup> to  $10^{-1}$  s<sup>-1</sup>, with thermal expansion playing a negligible role here and with the crystals better "memorizing" the effect of electric current pulses when deformed at a higher strain rate. References 5: all Russian.  
[44-2415/12955]

## TEMPERATURE DEPENDENCE AND STRAIN-RATE DEPENDENCE OF DEFORMATION RESISTANCE OF LOW-CARBON AND LOW-ALLOY STEELS

Moscow ZAVODSKAYA LABORATORIYA in Russian Vol 51, No 9, Sep 85  
(manuscript received 14 May 84) pp 60-63

VASYUTIN, A. N. and KLYUCH, A. S., Central Scientific Research and Planning Institute for Construction Metal Work imeni N. P. Melnikov, Moscow

[Abstract] Eight different known theoretical and empirical equations describing the stress in metals as function of temperature and strain rate are comparatively evaluated, on the basis of experimental data, to determine the best fit for low-carbon steels and low-alloy steels covering the various modes of deformation. According to established concepts and theory, there are four regions in the  $T-\dot{\epsilon}$  plane corresponding respectively to: I) athermal plastic deformation with the yield point negligibly dependent on temperature and strain rate; II) thermally activated plastic deformation with the yield point appreciably dependent on temperature and strain rate; III) plastic deformation with twinning and the deformation resistance only slightly dependent on temperature and strain rate; IV) plastic deformation with ductile pinning of dislocations by phonons and extremely strong dependence on the strain rate. Disregarding the effects of stress suddenly dropping beyond the upper yield point and then remaining constant before rising beyond the lower yield point, a relation is derived on the basis of the Arrhenius law analogous to the equation of high-temperature creep for solids or of laminar flow for viscous fluids. This relation is modified to the forms  $\sigma = \sigma_0 + \frac{kT}{\dot{\epsilon}_0} \sinh^{-1}(\frac{\dot{\epsilon}}{\dot{\epsilon}_0} e^{U_0/kT})$  or  $\sigma = \sigma_0 + CT \cdot \log(z + \sqrt{z^2 + 1})$  ( $z = A \cdot e^{B/T}$ ,  $A = 1/\dot{\epsilon}_0$ ,  $B = U_0/k$ ,  $C = k/\alpha$ ,  $U_0$  - activation energy,  $\alpha$  - activation volume,  $k$  - Boltzmann constant,  $T$  - temperature,  $\dot{\epsilon}$  - strain rate,  $\dot{\epsilon}_0$  - athermal component of strain rate,  $\sigma$  - deformation resistance,  $\sigma_0$  - athermal component of deformation resistance). A power law approximation of the deformation curve for slipping alone  $\sigma/\sigma_T^s = (\dot{\epsilon}_s/\dot{\epsilon}_T^s)^m$  and for twinning alone  $\sigma/\sigma_T^t = (\dot{\epsilon}_t/\dot{\epsilon}_T^t)^n$  yields  $(\sigma/\sigma_T^s)^{1/m} + (\sigma/\sigma_T^t)^{1/n} = 1$ . This relation with  $A = 6.9 \cdot 10^{-9} \text{ s}$ ,  $B = 5.64 \cdot 10^3 \text{ K}$ ,  $C = 0.101 \text{ MPa/K}$  and  $\sigma_0$ ,  $\dot{\epsilon}_0$ ,  $\alpha$ ,  $U_0$  independent of the temperature is applicable to low-carbon steels and low-alloy steels over the 100-300 K temperature range and the  $10^{-4}$ - $10^4 \text{ s}^{-1}$  range of strain rates. References 21: 6 Russian, 15 Western (3 in Russian translation). [44-2415/12955]

## INSTRUMENT FOR MEASURING STRENGTH OF FILM ADHESION TO ELASTIC SUBSTRATE

Moscow ZAVODSKAYA LABORATORIYA in Russian Vol 51, No 9, Sep 85  
(manuscript received 27 Mar 84) pp 78-79

SHKOLYAR, V. S., RAZINKOV, A. I. and KORNEYEV, A. V., Kiev Technological  
Institute of Light Industry

[Abstract] A high-precision laboratory instrument has been developed and built for measurement of both cohesion strength and adhesion strength of magnetic tapes and cinematographic films on elastic substrates. It consists of a motor-driven rotating hollow drum, with a special wide circumferential groove on the outside into which a strip specimen of elastic substrate with the film coating is laid and with a notch through which both ends of the elastic strip are fastened on the inside. A tool bit is pressed with its cutting edge against the film, through a spring mechanism with force regulation by means of a screw. The drum is rotated so that the film on the substrate will move under the cutter edge at a linear velocity of 10 mm/min. The force of film cohesion or adhesion, depending directly on the depth of cutter penetration into the coating, is determined from the motor torque required to drive the drum at the given speed. A d.c. electric motor MN-145 is used for this purpose, with the field voltage set for the initial torque and with subsequent armature regulation. The instrument with a drum 120 mm in diameter and with a cutter having an 0.8 mm wide edge was experimentally used for T-22/25/27 photographic films and "Sigma" magnetic tapes; the adhesion strength of these materials found to be ranging from 2.4 MPa to 123 MPa. References 4: all Russian.  
[44-2415/12955]

## CRYOGENIC TENSION DEVICE FOR POLYMER MATERIALS

Moscow ZAVODSKAYA LABORATORIYA in Russian Vol 51, No 9, Sep 85 pp 81-82

AVAKYAN, R. A., NATRUSOV, V. I., VIKULOV, V. F. and TESLYA, V. G., All-Union Scientific Research Institute of Glass Plastics and Glass Fiber

[Abstract] A cryogenic chamber has been designed and built for the ZD-10/90 (GDR) tension device, which will make it possible to determine the tensile strength and the modulus of elasticity of polymer binder and glass-plastic materials at low temperatures. Specimens of polymer binder materials need to be made in the form of solid cylinders 185-200 mm in total length and with the diameter reduced to 25 mm over the gage length. Specimens of glass-plastic materials need to be made in the form of 200-250 mm long hollow cylinders with a 2-2.5 mm wall thickness and a 25 mm outside diameter. A specimen is held in clamps redesigned for a lower heat capacity, made accordingly smaller and of Kh18N9T steel with a lower thermal conductivity than that of the original material. The cryostat consists of two thin-walled

metal shells, one inside the other, hermetically welded to a lid on top and to a flange fitting at the bottom. A specimen is placed inside this chamber, with the stem of the upper clamp connected to the movable cross-arm and the stem of the lower clamp connected to the stationary cross-arm. The temperature is monitored with a TSPN-2A resistance thermometer, elongation is measured with prismatic knife edges made of high-strength steel and held by springs. The reliability of measurements with this device was checked against a class-3 reference dynamometer (accurate within 0.2% of maximum load 100 MN) for various epoxies and glass-reinforced Textolite.  
[44-2415/12955]

UDC (546.59+546.92):543.24

#### DETERMINATION OF PLATINUM-GROUP METALS AND GOLD IN SECONDARY RAW MATERIAL

Moscow ZAVODSKAYA LABORATORIYA in Russian Vol 51, No 9, Sep 85  
(manuscript received 1 Aug 84) pp 87-89

RAKHLINA, M. L., YERMOLINA, G. I. and ALEKSANDROVA, Ye. A., Severonikel Combine, Monchegorsk

[Abstract] A variant of sorption-spectral analysis has been developed for determination of gold and platinum-group metals (Pt, Ir, Pd, Rh, Ru) in secondary raw materials such as catalysts, fireclays, industrial and other scrap. It was tested on synthetic mixtures containing all those metals, using a 0.5 g specimen of sorbent from 200 cm<sup>3</sup> of 3 M HCl solution with 2 g SnCl<sub>2</sub> and boiling it for 1.5 h. Prior to sorption-spectral analysis, the sorbent filtrate was dried in a porcelain cup with 1 g CuO and then roasted at 650°C. For testing natural samples, and to ensure detection of gold, the latter are dissolved in an HCl+HNO<sub>3</sub>+HF mixture and the undissolvable residue is alloyed with Na<sub>2</sub>O before being added to another sample of the original solution. The solvent is vaporized and the residual salts are converted to chlorides by twofold evaporation with HCl concentrate, whereupon those chlorides are dissolved in 3 M HCl for sorption analysis. The reliability of this method was checked against atomic-spectral analysis. Its advantages are that it requires less time, is simpler, and requires only one specimen for determination of all those metals. References 4: all Russian.

[44-2415/12955]

# PREDICTING RESIDUAL USEFUL LIFE OF MATERIALS AND STRUCTURES BY ACOUSTIC EMISSION SIGNALS

Kiev PROBLEMY PROCHNOSTI in Russian No 9, Sep 85 (manuscript received 21 Jan 85) pp 21-25

STRIZHALO, V. A., GRISHKO, V. G. and STRELCHENKO, V. A., Institute of Strength Problems, UkSSR Academy of Sciences, Kiev

[Abstract] Accident prevention in modern technology, such as atomic energy, aircraft and ship building, high pressure containers and the like, depends greatly on the effectiveness of methods of determining the reserve useful life of a structure during actual use. Investigators have been interested in the development of defects and the time they take to reach critical dimensions. The present article reports on studies to determine the degree of damage and to predict residual useful life on the basis of acoustic emission AE signals from the test specimen. The first task in solving the question of the residual useful life of a test specimen is to determine the invariability of the model of material fracture dynamics in terms of AE parameters in respect to the range of possible changes of external influences. External influences are taken to be variations of temperature and pressure, as well as changes in the rate and form of loads. Calculations needed to determine the minimum number of models describing the response of a material to influence in the form of AE signals are presented and discussed. Results suggested that the degree of damage of the test subject could be identified by the first cluster of damage flaws, and if it falls in any other cluster of damages the basis of prediction statistics will be shifted in that direction. Calculation results confirm that the method for predicting extreme structural states of high-pressure casing types effectively shows likely useful life and agrees closely with experimental models. References 5: all Russian.

[49-12131/12955]

UDC 620.178.38:539.43

# EFFECT OF STRESS CONCENTRATION ON FATIGUE RESISTANCE OF REFRACTORY NICKEL ALLOYS DURING ASSYMETRICAL MULTICYCLE LOADING. REPORT 2

Kiev PROBLEMY PROCHNOSTI in Russian No 9, Sep 85 (manuscript received 11 Jul 83) pp 32-37

SINAYSKIY, B. N. and BELYAYEV, M. S., Institute of Strength Problems, Kiev and Moscow

[Abstract] Determination of the limiting state of heat-resistant nickel alloys with stress concentration given multicyclic loading and the complex action of cyclic and static loads, was studied using alloy EP109 at 800°C and

various discrete stress values. The destructive nature of stress was presented in a diagram of coordinates, which are explained. Results indicated that changes in the static component had less impact on changes in destructive cyclic stress in specimens with stress concentration than in smooth specimens. Indirect evidence of this was found in alloy EP109 in the increase of the surface containing fatigue cracks at the moment of failure. An approximate formula for experimental values is presented, but it does not take account of the influence of stress concentration on resistance to fatigue in an asymmetrical cycle. Experimental and calculated results were satisfactorily close. Divergence occurs only in the case of narrow coefficients of amplitude and a longevity of one hour. References 15: 13 Russian, 2 Western (in Russian translation).  
[49-12131/12955]

UDC 629.735.33.015.4-97

#### DURABILITY OF ALUMINUM ALLOY D16AT DURING TENSION UNDER RAPID HEATING CONDITIONS

Kiev PROBLEMY PROCHNOSTI in Russian No 9, Sep 85  
(manuscript received 28 Nov 83) pp 38-41

MUGALEV, A. P., SAVUSHKINA, Zh. I., UKRAINTSEV, G. V., SHARKOV, V. B. and KAMYSHOV, Yu. A., Moscow

[Abstract] Components of various machines and devices can be subjected to intensive rapid heating resulting in changes in the relationships between temperature and tension under which fracture occurs. While previous studies have not carried the process to the point of failure, the present article reports on strength factors when rapid heating is carried to the failure point. A xenon device with a special loading attachment gave a beam of up to 7000 kW/m<sup>2</sup> at the focal point. Results were compared with those for stationary heating methods. Analysis of the dimensional factors showed that temporary resistance of the test Al alloy can exceed that of standard samples by no more than 10%. Further tests with tension below the yield point, at values of 34 $\pm$ 1, 54 $\pm$ 1, 106 $\pm$ 1, 155 $\pm$ 4, 260 $\pm$ 11 and 306 $\pm$ 3 MPa, and heating rate of up to 1350°C/s, were characterized by unsteady and short-term processes of heat exchange and tension in the specimens. The rapid heating process was also reflected in changes in residual elongation of the specimens depending on the average integral temperature along the calculated length of the specimen. There was also a significant loss in plasticity. References 6: 4 Russian, 2 Western.  
[49-12131/12955]

## EFFECT OF AUSTENITE PHASE TEMPERING ON STRUCTURE AND PROPERTIES OF TEMPERED ALLOY OF THE Cu-Al-Zn SYSTEM

Kiev PROBLEMY PROCHNOSTI in Russian No 9, Sep 85 (manuscript received 16 Jun 84) pp 42-45

KONDRATYEV, S. Yu., YAROSLAVSKIY, G. Ya., CHAYKOVSKIY, B. S., ZOTOV, O. G. and MATVEYEV, V. V., Institute of Strength Problems, UkSSR Academy of Sciences, Kiev, Leningrad

[Abstract] The presence of reverse martensite in the structure of beta-alloys with Cu-Al bases results in their high shock-absorption capability and cavitation resistance. The present article reports on study of improving physico-mechanical properties such as these by supplemental tempering in the temperature range of meta-stable austenite. The test alloy had 7.5% Al and 17.2% Zn by weight, the rest being copper. After diffusion annealing at 500°C for 24 hours, the alloy was quenched from 700°C for 3 hours in water, before tempering at 300 and 400°C for 2 minutes to 8 hours. Dilatometric study of the test specimens showed that during quenching direct martensite conversion began at 30°C and ceased below room temperature. The microstructure of the resulting alloy was two-phased with roughly equal amounts of beta-phase austenite and martensite. Thermokinetic values of the nature and kinetics of the process further delineated the structural changes connected with it. Along granular borders and within beta-granules, disperse stable  $\alpha_2$ -phase particles were found that can significantly reduce the alloy's dissipation properties. The resulting martensite had high thermal resistance, and the alloy in general showed high plasticity. In the first stage there was a marked increase in relative elongation and impact strength, while in the second phase (20-60 min. at 300°C and 4-7 min. at 400°C) strength increased but damping capability, plasticity and impact strength declined.

References 4: 3 Russian, 1 Western.

[49-12131/12955]



UDC 669.295

WEAR-RESISTANT FILLER MATERIAL BASED ON TITANIUM CARBIDES AND BORIDES

Moscow TSVETNYYE METALLY in Russian No 9, Sep 85 pp 76-77

BAGROV, I. N., KUDINOV, V. D., SUMIN, V. I., KASIMOV, G. G. and MAKURIN, Yu. N.

[Abstract] A highly wear-resistant material has been developed, to replace scarce tungsten carbide (Relite-3), for buildup of standard lining panels by the in-furnace beading technology. The material is based on titanium carbides and borides, can be produced in the 0.63-2.5 mm grain-size fraction required by this beading technology and embedded in cupronickel alloys. It was experimentally processed in a DLShch 80x150 jaw crusher and poured into a steel shell. After it has been embedded in a cupronickel matrix with 20 wt.% Mn in various ratios ranging from 0.40:1 to 2.33:1, the composites were tested for microhardness and wear rate. The microhardness of all was found to be within the 24,000-26,800 MPa range at the grain center and within the 20,000-22,000 MPa range within the diffusion zone, thus higher than the microhardness of the TN-20 titanium alloy (170-180 MPa). The wear rate was found to decrease with increasing filler content, but without being directly related to the microhardness. References 3: all Russian.

[34-2415/12955]

UDC 543.422.8

DETERMINATION OF COMPOSITION AND THICKNESS OF Fe-Ni FILMS

Moscow ZAVODSKAYA LABORATORIYA in Russian Vol 51, No 9, Sep 85  
(manuscript received 2 Apr 85) pp 34-36

RUDNEVSKIY, N. K., MASHIN, N. I., KALININ, Yu. S. and TKEMALADZE, I. V.,  
Gorkiy State University

[Abstract] X-ray spectral analysis is proposed for effectively determining the composition and the thickness of Fe-Ni films, on the basis of using both  $\text{FeK}_{\alpha}$  and  $\text{NiK}_{\alpha}$  fluorescence lines. The linear dependence of their respective

intensities on the film surface density and on the ratio of the two metals in the alloy is established theoretically, taking into account the dependence of radiation absorption on film thickness and introducing a correction factor for absorption of the incident radiation. Experimental results obtained by this method with film specimens of the 79NM alloy (78.5-80% Ni) produced by vapor-phase deposition agree closely with those obtained by the conventional gravimetric method. References 6: all Russian.  
[44-2415/12955]

UDC 621.785.5:669.782.8:669.28

#### EFFECT OF IRON AND BERYLLIUM ADDITIONS ON HEAT RESISTANCE OF SILICIDE COATINGS ON TSMV-30 MOLYBDENUM ALLOY

Moscow IZVESTIYA AKADEMII NAUK SSSR: METALLY in Russian No 5, Sep-Oct 85  
(manuscript received 11 Aug 83) pp 159-163

ZAYTSEV, A. A., FEDORCHUK, N. M., LAZAREV, E. M. and KOROTKOV, N. A., Moscow

[Abstract] In an experimental study of silicide coating on the TSMV30 high-strength molybdenum alloy (0.01% C+ 30% W+ 0.1% Ti+ 0.1% Zr) such a coating was modified by addition of either iron or beryllium with NH<sub>4</sub>Cl as activator (2.5-5-10Fe:2NH<sub>4</sub>Cl, 1-2.5Be: 2NH<sub>4</sub>Cl) to the mixture of Si+ foambrick lumps in a 1:25 ratio, for the purpose of evaluating the effect of these additives on its heat resistance. The mixtures were heated under continuous vacuum to 400°C and, after decomposition of the activator  $2\text{NH}_4\text{Cl} \rightarrow 2\text{NH}_3 + \text{H}_2 + \text{Cl}_2$  at that temperature, further to 1100-1150°C for silicidation. Specimens of both modification and of the plain coating material were tested for heat resistance by heat treatment which consisted of fast heating to 500, 1300, 1450°C and holding at each temperature for 10 min, then for 2 h, and then for increasingly longer periods of time before fast cooling to room temperature until first cracks had appeared. Phase analysis of the coatings prior to these tests and with the oxide layer after testing was done by the x-ray-graphic method. Microstructural examination was done by the metallographic method. The distribution of elements was determined on the basis of x-ray microspectral analysis, also with a Cameca Co. MS-46 analyzer and under a JSM-U3 scanning electron microscope. The results have revealed that these coatings consist of two layers: a thin upper layer 5-10 μm thick formed by a solid solution of phases  $(\text{Mo}_{0.2}\text{Ti}_{0.8})\text{Si}_2$  and  $(\text{W}_{0.2}\text{Ti}_{0.8})\text{Si}_2$  on top of a thick lower layer formed by a solid solution of silicides  $\text{MoSi}_2$  and  $\text{WSi}_2$ . Added iron appears only in the upper layer, forming an alloy with those two phases. Added beryllium appears in both layers. Both increase the heat resistance of the coatings appreciably, in terms of longer life at those temperatures, but an excessive amount of iron lowers it. All coatings break down after 50-100 h at 500°C, owing to formation and precipitation of metal oxides  $\text{MoO}_3$  and  $\text{WO}_3$  in large volume fractions. The high resistance at high temperatures (1300-1450°C) is attributable to formation of a glassy  $\text{SiO}_2$  film which becomes more fusible and more yielding in the presence of small amounts of alloying elements (Ti, Fe, Be) so that it acquires the capability

of curing defects and relaxing thermal shock stresses. When this film swells and cracks under the pressure of vaporized metal oxides underneath, then the coating loses its protective quality. References 12: 11 Russian, 1 Western.  
[45-2415/12955]

UDC 621.793.7

## PRODUCTION AND STRUCTURE OF GAS-THERMAL COATINGS BASED ON Ni-Cr-B-Si ALLOYS

Kiev POROSHKOVAYA METALLURGIYA in Russian No 9, Sep 85 (manuscript received 24 Mar 81) pp 22-26

BORISOV, Yu. S., GORBATOV, I. N., KALINOVSKIY, V. R., FEDORENKO, V. K., SHURYGINA, Z. P., KOKORINA, N. N. and GOPIYENKO, V. G., Institute of Materials Science Problems, UkSSR Academy of Sciences

[Abstract] A technology was developed for obtaining coatings from commercial powders PG-SR2, PG-SR3, VSNGN-55 and VSNGH-35, as well as experimental composite powders and mechanical mixtures (wt. %): Al-0.05%Y; 80% Ni-20% Al composite powder; NiCr-5% Al (80% Ni, 20% Cr) composite powder; PG-KhN80Sr2 + 15% (TiCr)B<sub>2</sub> + 20% Mo composite powder; (SNGN-55) + 40% (TiCr)B<sub>2</sub> mechanical mixture and (VSNGN-35) + 35% (SNGN-55) + 15% (Ni-Al) mechanical mixture. This technology includes: 1) mixing the components, 2) adding an organic binder composite powder and 3) heating while continually mixing until the binder solvent is completely removed. The coatings were sprayed on, heated to a temperature 20-30°C above the initial melting temperature, held and cooled in vacuo or in air (if a protective AlY layer is used). Sufficiently dense coatings based on self-fluxing alloys were obtained on large parts without vacuum fusion by using Ni-Al exothermic reactive powders. The coating structures were studied by metallographic and X-ray analysis. The solidus-liquidus regions for PG-SR2, PG-SR4 and VSNGN-35 were determined by differential thermal analysis. Coatings on cylindrical specimens of 20Kh13 steel were tested for hydroabrasive wear resistance using EN-1.25 electrocorundum in a 333-US tester. The tests showed that the addition of hard components such as (Ti, Cr)B<sub>2</sub> improved the wear resistance of these coatings. References 7: 3 Russian, 4 Western.  
[46-12595/12955]

## MECHANISM OF FORMATION OF CHEMICAL RHODIUM COATINGS

Moscow ZASHCHITA METALLOV in Russian Vol 21, No 5, Sep-Oct 85  
(manuscript received 16 May 84) pp 774-777

VALSYUNENE, Ya. I. and YURYAVICHYUS, A. Yu., Institute of Chemistry and  
Chemical Engineering, LiSSR Academy of Sciences

[Abstract] A study of the autocatalytic chemical rhodium coating process was made, rhodium chloride in aqueous solution being reduced by agents such as  $\text{NaBH}_4$  or  $\text{N}_2\text{H}_4$  and the metal surface on which rhodium is deposited acting as catalyst. Experiments were performed with two baths,  $0.0106\text{M RhCl}_3 \cdot 4\text{H}_2\text{O} + 0.83\text{M ethylenediamine} + 0.025\text{M dimethyl glyoxime} + 1.5\text{M NaOH} + 0.011\text{M NaBH}_4$  (approximately 2 wt.% B) at  $90^\circ\text{C}$  for deposition of rhodium coatings and  $0.014\text{M RhCl}_3 \cdot 4\text{H}_2\text{O} + 0.03\text{M Na}_3[\text{Co}(\text{NO}_2)_6] + 1.166\text{M ethylenediamine} + 1.0\text{M NaOH} + 0.12\text{M N}_2\text{H}_4$  (approximately 20 wt.% Co) at  $75^\circ\text{C}$  for deposition of Rh-Co coatings on smooth platinum plates with  $10\text{ cm}^2$  surface area each. The process was initiated by touching the platinum plates with aluminum. The mass of coatings was measured by weighing, their boron content was determined with a JXA-50 microanalyzer and their cobalt(II) content was determined polarographically with a  $0.1\text{M ethylenediamine}$  supporting electrolyte. The experimental data have been interpreted theoretically, assuming a constant degree of rhodium oxidation during preparation of the baths. The polarization curves, plotted with a P-5827 M potentiometer in a YaSE-2 glass cell with a platinum auxiliary electrode and a  $\text{AgCl}$  reference electrode, together with calculations based on Faraday's law and analysis of the ionic reactions indicate a coupling between anodic oxidation of the reducer and cathodic reduction to rhodium  $\text{Rh(III)}$ . Electrochemical reduction is possibly accompanied by a potential-independent chemical reaction between  $\text{Rh(III)}$  and  $\text{BH}_4^-$ , while electrochemical deposition of cobalt is accelerated by addition of  $\text{N}_2\text{H}_4$ . References 8: all Russian.

[47-2415/12955]

UDC 621.357:620.193

## PHASE COMPOSITION, HARDNESS AND HEAT RESISTANCE OF DISPERSION-HARDENED NICKEL COATINGS

Moscow ZASHCHITA METALLOV in Russian Vol 21, No 5, Sep-Oct 85  
(manuscript received 14 Oct 83, after completion 15 Nov 84) pp 794-795

KHABIBULLIN, I. G., ZUBAREVA, G. V., IGNATYEV, V. N., KAZAKOV, A. N. and  
KHARCHENKO, V. A., Kazakh Institute of Chemical Engineering

[Abstract] Nickel coatings of  $60\text{--}70\text{ }\mu\text{m}$  thickness were deposited on St.45 carbon steel from an electrolyte consisting of  $300\text{ g/dm}^3\text{ NiSO}_4 + 45\text{ g/dm}^3\text{ NiCl}_2 + 30\text{ g/dm}^3\text{ H}_3\text{BO}_3$ , with  $5\text{--}50\text{ g/dm}^3\text{ ZrB}_2 + 10\text{ g/dm}^3\text{ SiO}_2 + 2\text{--}10\text{ g/dm}^3$  boron

added and held in suspension with a paddle wheel. The mass of  $\text{Ni} + \text{ZrB}_2 + \text{SiO}_2$  and  $\text{Ni} + \text{ZrB}_2 + \text{SiO}_2 + \text{B}$  coatings was measured by weighing, their heat resistance in air at  $1050^\circ\text{C}$  was measured in a tubular furnace, their hardness was measured with a PMT-3 tester. Their phase analysis was performed in a DRON-3 diffractometer, with a  $\text{CuK}\alpha$  radiation source. Qualitative determinations were made with an LMA-10 laser microanalyzer, its laser beam producing a crater  $20\text{--}30\text{ }\mu\text{m}$  deep and  $50\text{--}60\text{ }\mu\text{m}$  in diameter. Boron was determined on the basis of its  $246.6\text{ nm}$  line on a PGS-2 spectrograph. The data indicate an  $\alpha'$ -Ni phase with an f.c.c. crystal lattice. Codeposition of Ni and  $\text{SiO}_2$  appears to be stimulated by boron particles in very small concentrations and to be inhibited by boron particles in large concentrations. The intensity of  $\alpha'$ -Ni peaks on the diffractograms decreased even more appreciably as up to 4% B was added to the electrolyte. Annealing of the steel with either of the coatings at  $1050^\circ\text{C}$  further reduced the diffraction peaks and produced new peaks corresponding to  $\text{ZrSiO}_4$ ,  $\text{NiO}$ ,  $\text{ZrO}_2$ ,  $\text{B}_2\text{O}_3$ , and other compounds, all of them contributing to retention of hardness and high heat resistance after high-temperature annealing. High-temperature oxidation of coated steel was found to proceed according to the  $\Delta m^n = kt$  law with  $1.5 \leq n \leq 3$ .

References 2: both Russian.

[47-2415/12955]

UDC 539.219.2:665.93

CRACK BLOCKING IN SHEET ELEMENTS OF DESIGNS BY PLATES OF FIBROUS METAL COMPOSITES

Kiev PROBLEMY PROCHNOSTI in Russian No 9, Sep 85 (manuscript received 12 Jul 83) pp 70-74, 115

YATSENKO, M. I., Mechanics Institute, UkSSR Academy of Sciences, Kiev

[Abstract] Composite materials with a metallic matrix (MCM) are receiving wide application, but cracking of such composites is a severe problem. Solutions have been sought by study of resistance of thin unbonded isotropic plastics to cracking, and study of elasticity theory, stability of unbonded thin layers under tension and mechanical properties of MCM. The present article reports on mathematical evaluation of the effectiveness of the use of bonding elements made of fiber composites for limiting crack spread in sheet construction materials. Results showed that "stoppers" of aluminum-steel composites with fiber reinforcement of a volume of 18-25% provide the same reinforcing with 25% less weight than traditional stoppers of V95 aluminum alloy. Unidirectional material structure is a key factor in MCM stoppers. References 18: 17 Russian, 1 Western.  
[49-12131/12955]

## CORROSION

### BAKU CONFERENCE AND EXHIBIT ON METAL CORROSION

Baku VYSHKA in Russian 13 Sep 85 p 3

[Interview with R. G. Rizayev, director of the Institute of Inorganic and Physical Chemistry and Corresponding Member of the AzSSR Academy of Sciences: "How to Protect Metal from Corrosion"]

[Text] New chemically stable polyester concretes and various kinds of polymer coatings for metals are presented at the All-Union exhibition "Achievements and Advanced Methods for the Protection of Metal and Metal Products from Corrosion" in the Academy of Sciences of the Azerbaijan SSR which opened on September 9th. It includes part of the permanent display at the VDNKh SSSR [Exhibition of the Achievements of the National Economy of the USSR] and exhibits which have been cited with medals and diplomas of the country's principal exhibition.

Corresponding Member of the USSR Academy of Sciences and Vice President of the Academy of Sciences of the Azerbaijan SSR, V. R. Volobuyev, opened the exhibition which the All-Union Interindustry Scientific Research Institute for the Protection of Metals from Corrosion of the USSR State Committee on Science and Technology, the VDNKh of the USSR and the republic Academy of Sciences organized. On the basis of the exhibition, a seminar has begun for specialists of the republic who are conducting research in the field of the anticorrosion protection of metals.

The director of the Institute of Inorganic and Physical Chemistry and Corresponding Member of the Academy of Sciences of the Azerbaijan SSR, R. G. Rizayev, at the request of an Azerinform correspondent, tells about the exhibition and the problems the participants of the seminar are discussing:

"One of the important reserves for the acceleration of scientific and technical progress and for increasing the profitability of production, is to increase the service life and reliability of production equipment and metal structures. For this, it is necessary to develop increasingly effective measures and means for protecting metals from corrosion. The purpose of the exhibition and the meeting of scientists and specialists in Baku is familiarization with the latest achievements in this field. The developments of scientific organizations, educational establishments, and enterprises of 40 ministries and departments of the country are being demonstrated. In the proceedings of the seminar, representatives of a number of the All-Union scientific research institutes, which are coordinating developments on the problem, are taking part together with the Azerbaijani specialists."

"Among the materials displayed are more than forty developments of the academic and industrial scientific research institutes, educational establishments, and enterprises of Azerbaijan. In particular, works are presented which have been carried out in the Institute of Inorganic and Physical Chemistry, the main establishment in the republic for research in the field of protecting metals from corrosion, and in the Azerbaijan Institute of Petroleum and Chemistry imeni M. Azizbekov, and other organizations.

9136

CSO: 1842/51



## STUDY OF THE FORMATION OF A PROTECTIVE COATING ON A HIGH COBALT CONTENT ALLOY

Riga IZVESTIYA AKADEMII NAUK LATVIYSKOY SSR: SERIYA KHIMICHESKAYA  
No 4, Jul-Aug 1985 (manuscript received 22 Mar 85) p 497

[Article by A. Yu. Arays, G. P. Sedmale, U. Ya. Sedmalis, Riga Polytechnical Institute]

[Text] In developing temperature-stable, corrosion-resistant coatings (Ct) for high cobalt content alloys, selection of the composition and the mechanism of protective Ct formation are of vital importance.

From the standpoint of the combination of required properties (temperature stability, electroinsulating properties, minimal interaction of the Ct with the alloy, etc.) glass-like coatings that form at temperatures of 750-820° are optimum for the purpose.

We chose lanthan-containing boron-phosphate glasses with a high molecular content of  $P_2O_5$  (75%) as the base for developing such coatings.

MnO turned out to be the optimum activator of coating adhesion with the high cobalt content alloy. BaO was added to improve the technological properties of the glasses.

The Ct were deposited onto a 110  $\mu\text{m}$  thick ribbon of 49KF high cobalt content alloy using the slip firing method. The Ct was 12-15  $\mu\text{m}$  thick.

The mechanism of Ct formation was first studied with a "Sameka-MS46" X-ray electron-beam probe microanalyzer. Specimens for the study were prepared by cross-cutting a 49KF alloy ribbon with a Ct and then polishing the surface of the cut. Specimens with no MnO in the Ct were studied to ascertain the role of MnO as an adhesion activator.

As the study results showed, a transition layer 1.5-2.5  $\mu\text{m}$  thick was formed in the Ct-metal contact zone. From the distribution of chemical elements making up the glass (P, La, Ba, Mn) and the high content cobalt alloy (Co) it was established that the transition layer had been formed as a result of interdiffusion of Co and P. Comparison of the depth of diffusion of Co into coatings with and without MnO showed that in the first case Co diffuses

only to the middle of the transition layer to the depth of 1  $\mu\text{m}$ , whereas in the second case it diffuses through the entire depth of the transition layer and with much more intensity than on the surface of the metal. In both cases Co dissolved slightly into the glass melt as well. The remaining elements (La, Ba, M) that are part of the glasses are evenly concentrated only in the Ct and do not take part in the formation of the transition layer.

Thus, it can be assumed that Ct-metal adhesion is formed due to interdiffusion of only certain elements of the Ct and metal, Co and P in particular. The role of  $\text{MnO}$  as the adhesion oxide is apparently in the fact that it suppresses the diffusion of Co out of the metal and thus facilitates the formation of a strong Ct-metal bond and preservation of the magnetic properties of the high cobalt content alloy and the dielectric properties of the coating.

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12770/12955

CSO: 1842/58

ANODIC AND CORROSION BEHAVIOR OF TiC, TiN, TiB<sub>2</sub> IN H<sub>2</sub>SO<sub>4</sub> AND H<sub>3</sub>PO<sub>4</sub> SOLUTIONS

Moscow ZASHCHITA METALLOV in Russian Vol 21, No 5, Sep-Oct 85  
(manuscript received 8 Oct 84) pp 682-688

TOMASHOV, N. D., CHUKALOVSKAYA, T. V., MEDOVA, I. L. and YEGOROV, F. F.,  
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[Abstract] The anodic behavior and the corrosion resistance of TiC, TiN, TiB<sub>2</sub> in H<sub>2</sub>SO<sub>4</sub> and H<sub>3</sub>PO<sub>4</sub> solutions was evaluated in comparative tests covering a wide concentration range (1-10N) and a wide temperature range (25-90°C). Cylindrical specimens approximately 10 mm high and 10 mm in diameter had been produced for this experiment by cold pressing of powder and subsequent sintering at 2100-2200°C, carbide and diboride under a vacuum of 10<sup>-3</sup> mm Hg and nitride in an atmosphere of pure nitrogen. The chemical composition of the specimens was nearly stoichiometric (TiC<sub>0.99</sub>, TiN<sub>0.99</sub>, TiB<sub>1.99</sub>), the porosity of carbide specimens was 2-3% and the porosity of nitride and diboride specimens was 10%. The corrosion resistance of all three materials was found to decrease with rising temperature and with rising acid concentration, the nitride having the most positive potential (ø 0.5 V) and correspondingly the lowest corrosion rate in 5N H<sub>2</sub>SO<sub>4</sub> at 50°C. Its anodic potentiodynamic curve reveals three ranges of current density increase with rising potential, associated respectively with: 1) all three possible thermodynamic reactions from 0.5 V to 0.9 V; 2) formation of hydroxides Ti(OH)<sub>3</sub> and TiO<sub>2</sub>·H<sub>2</sub>O from 1.0 V to 1.5 V; 3) release of oxygen above 2.0 V. In the case of carbide these three ranges are associated respectively with: 1) ionization of absorbed hydrogen from -0.04 V to +0.3 V; 2) oxidizing dissolution from 0.8 V to 1.1 V; 3) redissolution with release of oxygen above 1.8 V. A comparison with the behavior of pure titanium VT1-0 and the Ti+ 0.2% Pd alloy reveals that all three titanium compounds in the passive state dissolve in acids faster than metallic titanium, probably owing to the high defectiveness of their oxide surface layers. References 22: 15 Russian, 7 Western (1 in Russian translation).

[47-2415/12955]

## USE OF TRACK AUTORADIOGRAPHY FOR CORROSION STUDY OF STEELS CONTAINING NITROGEN

Moscow ZASHCHITA METALLOV in Russian Vol 21, No 5, Sep-Oct 85  
(manuscript received 27 Aug 84) pp 689-697

KASPAROVA, O. V., MILMAN, V. M. and KHOKHLOV, N. I., Scientific Research  
Institute of Physical Chemistry imeni L. Ya. Karpov

[Abstract] The effect of adding nitrogen to austenitic stainless steels on their resistance to intergranular corrosion in acidic media at passivation

potentials and in the overpassivation range can be effectively evaluated by track autoradiography, this method being based on the 0.63 MeV nuclear reaction  $^{14}\text{N}(\text{n},\text{p})^{14}\text{C}$  on thermal neutrons with a 1.75 b cross-section for activation. This has been demonstrated on 1 mm thick strip specimens quenched in water from 1200°C or 1100°C after 30 min heating and with subsequent tempering at 650°C for 10 h or 100 h, or at 900°C for 10 h. The electrochemical characteristics, including corrosion behavior in 1N  $\text{HClO}_4$  + 0.25N NaCl solution which is highly sensitive to selective chromium depletion, were examined on the basis of potentiodynamic polarization curves with the potential shifted at a rate of 3.6 V/h from the corrosion point to 1.3 V n.h.e. Tracks of 0.53 MeV protons were recorded by a detector made of cellulose acetobutyrate which is not sufficiently sensitive for recording individual protons. The cadmium ratio in the reactor channel must be sufficiently high, of the order of 300, to suppress interference tracks of  $^{54}\text{Fe}(\text{n},\text{o})^{51}\text{Cr}$  and  $^{62}\text{Ni}(\text{n},\text{o})^{59}\text{Fe}$  reactions on fast neutrons. Halogen compounds on the electrode surface could but do not increase the track density by contributing  $^{35}\text{Cl}(\text{n},\text{p})^{35}\text{S}$  and  $^{35}\text{Cl}(\text{n},\text{o})^{32}\text{P}$  reactions on thermal neutrons. Track autoradiography combined with structural examination has confirmed the beneficial effect of nitrogen on the stability of grain boundaries during transition from active to passive state, probably by inhibiting the carbide formation, polarization measurements having monitored the corresponding potential-dependent electrochemical behavior of excess phases containing

nitrogen. The authors thank Academician Y. M. Kolotyркиn for valuable comments on the manuscript and S. D. Bogolyubovskiy for supplying the steel specimens. References 24: 18 Russian, 6 Western.  
[47-2415/12955]

UDC 620.194.8

#### EMBRITTLEMENT OF HIGH-NICKEL ALLOYS IN MEDIA CONTAINING $\text{H}_2\text{S}$

Moscow ZASHCHITA METALLOV in Russian Vol 21, No 5, Sep-Oct 85  
(manuscript received 14 Sep 84, after completion 5 Dec 84) pp 709-716

GUTMAN, E. M., MIKHEYCHIK, A. P., ANTONOV, V. G., ZHDANOVA, A. S.,  
ARTSISHEVSKAYA, L. F. and GARNIK, Yu. M., All-Union Scientific Research  
Institute of Natural Gases

[Abstract] An experimental study of high-nickel alloys 36NKhTYu, 36NKhTYuM5, 36NKhTYuM8, 40NKhTYuMD and of 12KhN1810T steel in media containing  $\text{H}_2\text{S}$  was made, for an analysis of their embrittlement in such media. Wire specimens 0.95-1.85 mm in diameter and 130 mm long were quenched and cold worked or quenched and tempered to maximum hardenability. After their surface had been polished with grade-00 emery paper and degreased, these specimens were placed for 168 h in vaporous or liquid 5% NaCl + 0.5%  $\text{CH}_3\text{COOH}$  solution deaerated and saturated with H S at temperatures of 20-110 C and under pressures of 0.2-1.8 MPa, or with  $\text{CO}_2$  (partial pressure 3.0 MPa) or  $\text{CO}_2:\text{H}_2\text{S} = 1:1$  mixture (total pressure 3.0 MPa) at a temperature of 20-5°C, simulating the environment around deposits of natural gas in Oranienburg and Astrakhan regions. Not later than

half an hour after soaking in those media, the specimens were tested for embrittlement under a tension equal to 2% of their ultimate strength, in a K-5 torsion machine rotating at 60 rpm. The measure of embrittlement was the ratio  $H = (N_0 - N_C) / N_0$ ,  $N_0 - N_C$  being the difference between the numbers of revolution till fracture in the initial state and after soaking in a corrosive medium respectively. The magnitude of this embrittlement index was found to generally increase with increasing partial pressure of  $H_2S$ , more embrittlement having been noted in liquid media than in vaporous ones. High solubility and slow diffusion of hydrogen in these alloys with an f.c.c. crystal lattice tend to reduced their embrittlement, however, the solubility of hydrogen increasing with higher nickel content and its diffusion being impeded by molybdenum. With a thinner alloy surface layer "saturated" with hydrogen, there will consequently be less embrittlement. An alloy becomes more embrittled under a higher partial pressure of  $H_2S$  especially when it has been cold worked after quenching, not so much more when it has been hardened by tempering. The degree of embrittlement generally depends on both phase composition and structural dispersion. In the case of a maximally hardened alloy it is determined by the chemomechanical strength reducing action in a corrosive medium so that it ceases to depend on the composition of that medium and thus on the partial pressure of  $H_2S$ . The embrittlement of some alloys and of the steel decreases as the temperature rises to 50°C, because of the decreasing solubility of  $H_2S$  in the electrolyte and the easier molecu-lization of hydrogen. It then increases as the temperature rises further to 110°C, on account of a faster diffusion of hydrogen. The embrittlement of other alloys is almost independent of the temperature. References 17: 11 Russian, 6 Western (1 in Russian translation).  
[47-2415/12955]

UDC 669.14.018

# DEPENDENCE OF RESISTANCE OF HEAT-RESISTANT NICKEL ALLOYS TO HIGH-TEMPERATURE SALT CORROSION ON Ti:Al RATIO

Moscow ZASHCHITA METALLOV in Russian Vol 21, No 5, Sep-Oct 85  
(manuscript received 2 Jul 84, after completion 30 Oct 84) pp 734-740

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[Abstract] An experimental study of heat-resistant cast nickel alloys was made for the purpose of determining the effect of Ti+ Al addition on their resistance to high-temperature salt corrosion. Titanium and aluminum in various ratios were added to the EP958Vd alloy (0.1% C+ 17% Cr+ 5% Co+ 3% W+ 2% Mo+ 1.5% Nb+ 0.04% B). The total Ti+ Al content varied from 0 to 8%. A constant total of 7-8% Ti+ Al was added to other alloys containing 10-20% Cr. The Ti:Al ration varied over the 0.5 to 1.5 range. All alloys had been cast from a vacuum induction furnace into finger molds preheated to 950°C. Specimens were given the following heat treatment: quenching from 1170°C and aging at 950°C for 4 h. They were then tested for corrosion over a 24 h period in a 75%  $Na_2SO_4$  + 25% NaCl melt at 900°C. The mean corrosion rate

was determined on the basis of the loss of mass. It was particularly important to determine the combined effect of titanium and aluminum on the corrosion resistance, each of these two metals having a different effect when added alone. The results of this corrosion test, together with those of x-ray structural analysis and x-ray microspectral phase analysis, have revealed that changing the Ti:Al ratio from 0 to 1 increasingly inhibits high-temperature sulfate corrosion of those alloys but does not influence their high-temperature chloride corrosion. From the standpoint of both corrosion resistance and mechanical properties, Ti:Al = 1 is the optimum ratio with a total 6-8% Ti + Al. Only when more aluminum than titanium is added, does the resistance to high-temperature chloride corrosion increase with increasing aluminum content monotonically throughout the entire range (it does not change monotonically with increasing titanium content, but peaks at approximately 2% Ti). Also the dependence of the resistance to high-temperature sulfate corrosion on the chromium content changes as the Ti:Al is changed. That resistance decreases somewhat with higher chromium content, but not detrimentally even with 20% Cr, when the Ti:Al ratio is within the 0.4-0.6 range. As the ratio is increased, that resistance increases normally with increasing chromium content so that 16-17% Cr is required when Ti:Al = 0.7-0.8 and 13-14% Cr is required when Ti:Al = 1.4-1.6 to ensure an adequate resistance to high-temperature sulfate corrosion. References 16: 11 Russian, 5 Western (1 in Russian translation).  
[47-2415/12955]

UDC 620.197.3

# USING PRODUCTS OF PROCESSING BLACK-SEA ALGA PHYLLOPHORA NERVOSA AS INHIBITORS OF STEEL CORROSION IN ACIDS

Moscow ZASHCHITA METALLOV in Russian Vol 21, No 9, Sep-Oct 85  
(manuscript received 2 Apr 84) pp 753-756

POPELYUKH, G. M., TALAVIRA, L. I., GAZHA, P. A., BURTENKO, L. M. nad  
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[Abstract] A method of processing the Black Sea alga *Phyllophora nervosa* has been developed at the Institute which involves first dissolving the albumins by alkaline hydrolysis, then neutralizing the solution and subsequently acidifying it with HCl to a pH = 3-4. The high-molecular albumins precipitate from the solution and the low-molecular ones remain in it. Subsequent neutralization and vaporization yield a substance which, on a dry basis, contains 59.0-61.0% NaCl + 32.0-36.0% albumins + 5.0-6.2% carbohydrates. This product, called IFKh (Institute of Physical Chemistry) inhibitor, is a nontoxic odorous dark-brown liquid (density 1.17 g/dm<sup>3</sup>, dynamic viscosity 2.8 cP) miscible with solutions of bases and acids but not with organic solvents. This substance was tested for effectiveness as inhibitor of steel corrosion in acids. Specimens of St.3 carbon steel were immersed for 5 h in 22-86% H<sub>3</sub>PO<sub>4</sub> at 30-95°C with 1% IFKh inhibitor, this inhibitor concentration having been found to be

optimum. Its effectiveness at 80°C increases with increasing  $H_3PO_4$  concentration and in 86%  $H_3PO_4$  is maximum at 60°C. Specimens of St.3 carbon steel were also immersed for 5 h in 10% HCl at 20-95°C with 1% IFKh inhibitor, being most effective at that HCl concentration at any temperature. Specimens of 12Kh18N10T alloy steel were immersed for 2 h in 35% HCl at 2-60°C with 1% IFKh inhibitor, its effectiveness here decreasing with rising temperature. Hydrogenation tests were performed on specimens of St.65G carbon steel, first immersed in 4N HCl at 80°C and then checked mechanically for changes in plasticity. Here addition of the inhibitor was found to reduce hydrogen embrittlement by as much as 20%. Other tests performed on St.3 carbon steel were adding 20-120 g/dm<sup>3</sup>  $FeCl_3$  or 0.5-2.0 g/dm<sup>3</sup> urotropine to 10% HCl solution with 1% IFKh inhibitor at 85°C. These tests of 5 h duration have revealed that the effectiveness of the IFKh inhibitor decreases with increasing  $FeCl_3$  concentration and increases with increasing urotropine concentration.

References 6: 4 Russian, 2 Western.

[47-2415/12955]

## FERROUS METALS

### FERROUS METALLURGY INDUSTRY TASKS OUTLINED

Moscow PRAVDA in Russian 6 Aug 85 p 3

[Unsigned editorial]

[Text] Beginning 1 January 1986 a number of important ferrous metallurgical enterprises and combines will learn to handle new management methods directed at the acceleration of scientific and technical progress and the improvement of product quality. Their experience in the use of reserves should become a school for the entire sector. The needs of industry for metal of high quality and for more varieties of metal increase from year to year. Modern industries require, as a rule, steels with prespecified properties that are suitable for the production of specific items. Moreover, the shape of the rolled metal should approximate the shape of the finished item. And if the metal does not satisfy these requirements, then even when its total production volume increases, a shortage will be felt all the same.

In the press, including on the pages of PRAVDA, it has mentioned more than once that the technical line of the sector up to recent times reflected its extensive development to the detriment of the mass introduction of advanced technologies and a fourth process stage which improve quality and reduce metal losses. It is impossible to operate that way now. The industries have to carry out a fundamental technical retooling throughout the entire industrial chain--from the mining of the ore to shipment of the finished metal. All links in the industrial chain must be included in the process of renovating production. It is necessary to improve the enterprises of the mining industry and the concentrating mills and to modernize many of the by-product coke industry plants. It is necessary to unrelentingly improve the production structure by gradually replacing open-hearth furnaces with converters and electric furnaces.

In February of this year a decree was adopted by the CPSU Central Committee and the USSR Council of Ministers regarding the further development and technical retooling of the ferrous metallurgical industry and the improvement of metal product quality. Now that program is being practically realized. Some 14 sector and 8 all-union target programs have been worked out and are already being put into effect, the tasks of which have been communicated to specific enterprises. Each plant and combine must have a clear perspective of production renovation on the basis of which to formulate annual and



five-year plans for reconstruction and technical retooling. At the same time, a check has shown that at a number of metallurgical enterprises the tasks still have not been given to the basic shops and have not been discussed in the labor collectives, and no specific measures have been defined for their realization. The task of party and trade union committees and of managers is to take urgent measures for mobilizing the collectives, and above all, the engineering services for carrying out the tasks with respect to technical retooling.

On the initiative of the AvtoBAZ collective, socialist obligations directed toward achieving higher indicators for the acceleration of scientific and technical progress and for the growth and efficiency of production relative to the control figures for the upcoming Twelfth 5-Year Plan are now being adopted in the country. The Cherepovets Metallurgical Combine was first among metallurgical enterprises to support the initiative of the Volga-area people. It has planned an extensive program for the technical retooling of the enterprise, for the use of resource-saving technologies, and for increasing metal product quality. To be included in this movement is a matter of honor for all workers of the industry.

The rebuilt plants will have to operate in the next century. Are technical decisions which will be effective in the long term always being incorporated in the renewal plans? Obviously, in this crucial stage for the ferrous metallurgical industry, it is advisable to pay closer attention to the introduction of the latest technologies which reduce the costs of mining and concentrating the natural raw material. At present a large portion of all capital investments in ferrous metallurgy is spent on the mining industries. It should not be forgotten that the ore and coal reserves are limited and irreplaceable.

Points of reference when planning the reconstruction of the enterprises are high efficiency, economical consumption of material and financial resources, and the introduction of advanced technologies. It is time to get rid of obsolete methods of casting steel in which millions of tons annually end up in scrap. It is impossible to accept the intolerably slow introduction of continuous steel-casting facilities, which would produce savings of metal and energy and would simplify and improve the efficiency of rolled-steel production. The widespread use of continuous steel casting is the direct path to increasing the efficiency and output of the ferrous metallurgical industry. Industry collectives are urged to take care that their products approximate to the maximum the shape of the future machine-building products, to increase the varieties of rolled steel, and to produce more thin sheet. It is necessary to more energetically develop the production of rolled components and other advanced efficient technologies.

Improvement of the base industry of our economy in many respects depends on the active support of associated industries.

The heavy machine-building enterprises, which produce mining, blast furnace, by-product coke, steelsmelting, and rolling equipment, must increase the quality, reliability, and longevity of their products as well as the degree

of standardization. The company (firmennoye) maintenance of this equipment must be developed to a greater extent to help decrease downtime and repair costs. It is important to raise the level of the production organization by strengthening discipline and order in the collectives and by actuating reserves for increasing labor productivity.

In the first half of the year many ferrous metallurgical enterprises operated below their capabilities. The party committees of the enterprises, together with managers and trade union organizations, are urged to rigorously analyze the work results, and to do all so as to achieve a clear-cut fulfillment of all of the year's contractual obligations for the entire range of products.

Maximum utilization of all the potentialities of the new equipment and advanced technologies and daily shock work will enable the metallurgists to achieve planned party goals and to worthily meet the 27th CPSU Congress.

12863/12955  
CSO/1842:26

## DISCOVERY LINKS ELECTRON CONCENTRATION TO HEATING

Moscow IZVESTIYA in Russian 16 Aug 85

[Article by I. Novodvorskiy]

[Text] On 15 August 1985, the USSR State Commission for Inventions and Discoveries registered a discovery made at the Moscow Institute of Steels and Alloys by USSR Academy of Sciences Corresponding Member V. Yelyutin and Doctors of Technical Sciences A. Manukhin and Yu. Pavlov.

New technologies are the basis of scientific-technical progress. In particular, the technologies of producing modern structural materials and metals with special properties. The discovery made by the Moscow scientists has a very direct relationship to this problem. For a long time they have studied the electrophysical properties of semiconductor metal oxides and the processes for reducing them to pure metals with the aid of carbon and hydrogen. Numerous theoretical studies and experiments showed that such reduction processes proceed especially intensively when heating to temperatures such that the oxide semiconductor acquires an intrinsic conductivity as a result of a sharp increase in the concentration of free electrons.

The electron concentration may be increased not only by heating but also by special additives, strong electric or magnetic fields, laser radiation and other methods.

The discovery has great fundamental significance, because it provides a means for a deeper understanding of the fundamental nature of chemical reactions in solids. Furthermore, a scientific basis is created for developing new, effective technologies for metallurgy and the production of semiconductors and composite materials.

12863/12955

CSO: 1842/26

## COMPLAINT ABOUT AUTOMATION PARTS SHORTAGE

Moscow SOTSIALISTICHESKAYA INDUSTRIYA in Russian 13 Oct 85 p 1

[Article under rubric "A Sharp Signal" "Unemployed Robots" consisting of a letter from steelmakers P. Kolodiy, V. Shvidkov, A. Karpenko and P. Omelchuk of the oxygen converter shop of the Metallurgical Plant imeni Petrovskiy and an interview, based on the letter, by special correspondent V. Pryadko with Yu. Goncharov, general director of Dneprchermetavtomatika NPO [Dnepropetrovsk Ferrous Metal Automation Scientific Production Association]; slant lines distinguish the letter, printed in italics in source]

[Text] Dnepropetrovsk. / In recent years, a large amount of new equipment, which substantially raises the productivity of the metallurgical units and improves working conditions, has been arriving in the shop of our enterprise which is the oldest in the Dnieper region. Nevertheless, a certain share of manual and heavy labor is retained, for example, in the measurement of temperature of finished steel and the taking of samples for chemical analysis. The converter vessel is slowly inclined and a steelmaker, with an almost 20-kilogram ladle, scoops up metal and rapidly backs away.

The operation takes about a minute. After this, another half minute is required to measure the temperature of the steel. But even such short intervals of time breathing the heat of the unit is not easy.

And yet for us, robots have been developed. Specialists of the central laboratory for automation and mechanization of the plant together with workers of the Dneprchermetavtomatika NPO have developed and installed manipulators in our oxygen converter shop with which the measurement of the temperature of the steel and the taking of a sample of steel can be done without inclining the converter vessel. The progressive innovation vastly eases our work and reduces the time for these operations. The duration of each melt is diminished, on the average, by two minutes. For our plant this is an additional 30,000 tons of steel a year. Utilization of the manipulators contributes to an increase in the durability of the converters.

Very soon, however, our robots, in essence, have remained unemployed. The plant is being fully provided with these selfsame sample-taking manipulators. But thermocouple units which measure temperature have been installed in association with them. And there are not enough of these.

No matter where the plant providers turned either in Ukrglavpribor  
or in Soyuzglavpribor.  
, there is no improvement. We are receiving a meager number of them,  
but 72,000 are needed for the annual program.

And here is the result. The manipulators stand idle, and we, the steelmakers,  
again are taking up the heavy ladle. /

\* \* \* \* \*

I acquainted Yu. Goncharov, general director of the Dneprchermetavtomatika  
Scientific Production Association, with the letter from the workers.

"Yes indeed" said he, "thermocouple units are in very short supply. The  
enterprises of Minpribor [Ministry of Instrument Making, Automation Equip-  
ment, and Control Systems] are keeping the metallurgists, as it is said, on  
a starvation ration. But this is only one side of the problem. The  
selfsame manipulators which we are producing in an experimental plant in  
Zaporozhe do not suffice. The capability of the enterprise is small, many  
times less than the demands of industry."

"We in the Ministry of Ferrous Metallurgy for many years already have been  
trying to get decisions for the expansion of the experimental plant but so  
far, unsuccessfully. Now our specialists have developed another combination  
sampler which determines both the temperature and the state of oxidation of  
the steel. The introduction of novelties into production, however, is held  
back by the weak production base."

9136  
CSO: 1842/51

## STUDY OF FILTRATION OF CAST IRON THROUGH SLAG MELTS

Dnepropetrovsk METALLURGICHESKAYA I GORNORUDNAYA PROMYSHLENNOST in Russian  
No 3, Jul-Sep 85 pp 7-9

CHERNOV, N. N., SAFINA, L. A., DEMIDENKO, T. V. and RIZNITSKIY, I. G.,  
Dneprodzerzhinsk Industrial Institute and Krivoy Rog Metallurgical Combine

[Abstract] The slag of a single composition was simultaneously melted in four crucibles. After complete melting, crucibles containing cast iron filings were lowered in the furnace onto the slag crucibles. Five apertures 4 mm in diameter were drilled into the bottoms of the upper crucibles, through which the cast iron after melting flowed downwards and was filtered through the slag layer. Pure cast iron, cast iron preliminarily mixed when cold with coke dust, pure cast iron but with the coke dust on the surface of the slag and cast iron without coke dust placed directly on the melted slag were used. Cast iron preliminarily mixed with coke dust was filtered much more poorly than pure cast iron. Practically all the cast iron passed through the slag with coke dust on its surface. When cast iron was placed directly onto the surface of the melted slag, the nature of the drainage was somewhat different. As the cast iron melted it passed through the layer of melted slag, with some metal beads remaining in the slag and some retained by the graphite crucible walls. It is concluded that the proper quantity of ore charge should be determined for each blast furnace as a function of its volume and the quantity of coke used. Reference 1: Russian.  
[42-6508/12955]

## RESULTS AND PROSPECTS FOR DEVELOPMENT OF OUT-OF-FURNACE TREATMENT OF STEEL AT METALLURGICAL ENTERPRISES OF THE UKRAINE

Dnepropetrovsk METALLURGICHESKAYA I GORNORUDNAYA PROMYSHLENNOST in Russian  
No 3, Jul-Sep 85 pp 14-16

SHNEYEROV, Ya. A. and OGRYZKIN, Ye. M., Institute of Ferrous Metallurgy, USSR  
Ministry of Ferrous Metallurgy

[Abstract] Significant changes have occurred in the development of out-of-furnace treatment of steel, though some of the steps called for by the 'Metall' Research Program have not been undertaken. Treatment of steel in the ladle by neutral gases primarily involves feeding of a neutral gas into the ladle through a submerged tuyere. Argon and nitrogen are used to homogenize the composition of the steel in the ladle. Powdered silicocalcium is injected into steel to achieve desulfuration and modify nonmetallic inclusions. Steel is treated in the ladle with synthetic slag and vacuum treatment is used to remove hydrogen, though the process is expensive. The authors call for

continued effort to manufacture and install equipment for combined treatment of steel in the ladle with argon and the manufacture and installation of vacuum devices with improved refractories.  
[42-6508/12955]

UDC 669.184.126.22.26]:669.054.8.003.12

# CONVERSION OF OXYGEN-CONVERTER SHOP CONVERTERS AT AZOVSTAL TO COMBINED INJECTION WITH INCREASE IN SCRAP CONTENT TO 40-45%

Dnepropetrovsk METALLURGICHESKAYA I GORNORUDNAYA PROMYSHLENNOST in Russian  
No 3, Jul-Sep 85 pp 16-17

KRIVCHENKO, Yu. S., NIZYAYEV, G. I., CHEKHUTA, V. I. and LAPITSKIY, V. V.,  
Ukrainian State Institute for Planning of Metallurgical Plants

[Abstract] The author's Institute has developed a plan for conversion of the oxygen-converter shop of the Azovstal Combine to combined injection in order to increase the consumption of scrap in the charge to 40-45% of the weight of the metal charge and improve the quality of the metal produced. The technology of combined injection was developed by the Institute of Ferrous Metallurgy and calls for three successive stages: blowing of oxygen through the metal from the top, with neutral gas injected through bottom tuyeres; heating of the scrap from above with subsequent top injection of oxygen combined with bottom tuyere injection of neutral gas for 30-35% scrap charges; heating of scrap with fuel-oxygen blast through bottom tuyeres and the top tuyere burner with subsequent blowing of oxygen through from both bottom and top for 40-45% scrap charges. The introduction of combined injection and the increase in scrap content to 40-45% will result in the significant savings of cast iron and decrease in the cost of the steel produced at the plant. The work is planned in stages.

[42-6508/12955]

UDC 669.18.046.55:66.094.237-426]:66.065.5

# INFLUENCE OF TWO-STAGE DEOXIDATION OF STEEL WITH ALUMINUM IN THE LADLE AND CRYSTALLIZER ON QUALITY OF CONTINUOUS CAST BILLETS AND ROLLED PRODUCTS

Dnepropetrovsk METALLURGICHESKAYA I GORNORUDNAYA PROMYSHLENNOST in Russian  
No 3, Jul-Sep 85 pp 17-19

NOSCHENKO, O. V., YESAULOV, V. S., SEMENKOV, V. I., YEMELYANOV, V. V.,  
LEONOV, I. A. and MOISEYEVA, L. A., Azovstal Combine; Institute of Ferrous Metallurgy, USSR Ministry of Ferrous Metallurgy

[Abstract] The authors' institute and combine have developed a technology for two-stage deoxidation of steel type 17G1SU with aluminum in the

steel-pouring ladle and with wire in the crystallizer to decrease the consumption of aluminum and stabilize its content in the metal. The new process significantly reduces the total consumption of aluminum, decreases the content of nonmetallic inclusions in hot rolled sheets and increases the impact strength at temperatures below freezing. References 2: both Russian.  
[42-6508/12955]

UDC 621.771-97:[669.15-194:546.621

#### EFFICIENT CONDITIONS OF HOT ROLLING OF 08YuA STEEL

Dnepropetrovsk METALLURGICHESKAYA I GORNORUDNAYA PROMYSHLENNOST in Russian  
No 3, Jul-Sep 85 pp 23-24

YARTSEV, K. K. and BOROBEY, S. A., Institute of Ferrous Metallurgy, USSR  
Ministry of Ferrous Metallurgy

[Abstract] In order to determine the optimal conditions of completion of hot rolling, the method of experimental planning was used to study the influence of temperature at end of rolling and coiling temperature on the microstructure and mechanical properties of hot rolled steel alloyed with aluminum. Strips 4 mm thick were rolled at 9 m/s on a 1700 mill with temperature of the product at the intake to the finishing group of the mill varied so as to change the temperature of the end of rolling from 870 to 960°C. Coiling temperature was from 680 to 770°C, which was controlled by regulating the quantity of water sprayed on the metal after rolling. Regression equations were derived to describe the variation in yield point, hardness and relative elongation of the sheet steel as a function of temperature at the end of rolling and coiling temperature. It was found that the most favorable microstructure and mechanical properties of steels for cold stamping were obtained by completion of rolling at 870-920°C and coiling at 680-720°C.  
[42-6508/12955]

UDC 669.184.244.66

#### PRODUCTION OF HIGH QUALITY CHROMIUM STEEL IN CONVERTERS

Moscow STAL' in Russian No 9, Sep 85 pp 24-25

SHALIMOV, A. G., KOSOY, L. F., YABUROV, S. I., NOSOCHENKO, O. V. and KHARAKHULAKH, V. S., Central Scientific Research Institute for Ferrous Metallurgy; Azovstal' Metallurgical Combine

[Abstract] Considerable importance is attributed to expanding the product mix of alloyed steels, especially those containing chromium, that can be produced in converters. The present article reports on 10KhSND and 30KhN2MF, steels with 0.6-1.2% Cr, produced in 350-ton converters at the Azovstal'



combine. The steel was made from recycled scrap containing no more than 0.020% sulfur, nickel, copper, ferromolybdenum and desulfurized iron. After the blow the metal contained 0.01-0.07% C, 0.07% Mn, 0.005-0.014% S, and 0.001-0.007% P. The melting time of the first stage was prolonged to eliminate impurities and correct the chemical composition; later melting times were 50 minutes. After initial processing the metal was purged with argon for 7-20 minutes through a tuyere at gas pressure of 0.392-0.588 MPa at a rate of 50-90 cubic meters/hour. The finished steel had 0.005% sulfur and 0.009% phosphorus, thus meeting GOST standards for extra-high-quality steel.

[39-12131/12955]

UDC 669.168:65.011.56

#### PRINCIPLES OF CONTROL OF CHARGE MIX PROPORTIONS IN LARGE FERROALLOY FURNACES

Moscow STAL' in Russian No 9, Sep 85 pp 37-40

GODYNA, V. V. and STEPANYANTS, S. L., NIIA chermet

[Abstract] In recent years large-scale electric furnaces for producing ferroalloys have become more common. Control of the amount of carbon and the reducing agent is a key factor in determining product features and maintaining production continuity. Break-downs had been attributed mainly to wide variations in moisture in the coking coal used for reducing the mix into the finished product. Various problems involving the reducing agent have indicated the need for new principles of charge mix monitoring based on modern automation and computer technology. The methodology was tested experimentally using a silicon-manganese-carbon charge variant and also controlling the basicity of the charge and the relation of carbon in the gas in the charge and that in solid form in the charge. Calculations for the chemical parameters are discussed. Stabilization of the basic charge with control of carbon and moisture content as well as manganese and silicon offered improved metal and fewer plant stoppages. Two steps are recommended for implementing the new process, the first stabilizing the chemical composition while limiting costs, the second monitoring the carbon balance in the furnace. References 4: all Russian.

[39-12131/12955]

## IMPLEMENTING PRODUCTION OF NEW HEAT-RESISTANT BEARING STEEL 8Kh4M4V2FI-Sh

Moscow STAL' in Russian No 9, Sep 85 pp 68-70

SINELNIKOV, M. I., SKRYNCHENKO, A. A., ANZINA, E. S., ANTIPENKO, G. I., MOSHKEVICH, Ye. I. and KONTER, L. Ya., Ukrainian Scientific Research Institute for Special Steel, Dneprospetsstal' Plant and All-Union Scientific Research Institute for the Bearing Industry

[Abstract] Bearings made of 8Kh4M4V9F2-Sh steel for use at high temperatures are limited in durability by technical features of the steel. The present article reports on development of a new steel, 8Kh4M4V2FI-Sh. In it the amount of carbide-forming elements was reduced to increase plasticity, tungsten was partially replaced with molybdenum, and titanium was added to permit better reduction of the metal and improved pulverization. Electroslag smelting was used to produce test ingots, from which specimens 20 X 20 X 20 mm were cut for metallographic testing. Results showed that in a temperature interval of 1000-1200°C, the excess phase was dissolved more rapidly in the new steel than in 8Kh4V9F2. This was especially true in the upper half of that range. The new steel also had improved plasticity in the deformation temperature range, and retained that plasticity through a broader temperature interval. Further study was made to perfect technology for mass production of the new steel. The quality of finished rods of 8Kh4M4V2FI-Sh satisfied standards for high-temperature bearing uses at a lower cost than the previously used steel.

[39-12131/12955]

UDC 669.14.018.255

## DETERMINING BASIC DURABILITY CHARACTERISTICS OF 9KhF ROLLER STEEL

Moscow STAL' in Russian No 9, Sep 85 pp 71-72

TIMONIN, V. M., YAROSHENKO, M. V., NIKOLAYEV, V. A. and MERINOV, G. N., candidates of technical sciences, Central Scientific Research Institute for Machinebuilding Technology Scientific Production Association, and Moscow Institute of Steel and Alloys

[Abstract] Various steels are used for rolling mill rollers. The present article reports on a study of 9KhF steel used for a variety of heavy rolling equipment. A prepared model roll sleeve was heated to 830-850°C. That temperature was held for 3 hours before cooling through water into oil, tempering at 402-440°C and holding for 100 hours. A theoretical stress coefficient of 3.2 was determined. Resistance to brittle failure of the roller steel was determined by non-centric tension of specimens with 50mm thickness. The tests showed that 9KhF steel has high static and fatigue durability, low plasticity and low resistance to brittle failure. Fatigue characteristics varied widely and showed sensitivity to the direction and precise locus of impact, a feature of brittle steels in general. References 2: both Russian.

[39-12131/12955]

## MONITORING AUSTENITE GRANULES IN HIGH-SPEED CUTTING STEEL

Moscow STAL' in Russian No 9, Sep 85 p 74

MOROZENKO, S. G., NATAPOV, B. E., MOSHKEVICH, L. D. and RYABIKINA, V. M.,  
 Ukrainian Scientific Research Institute for Special Steels

[Abstract] The article reports on study of ways to meet new state standards for granular microstructure of high speed cutting steels, so that granules will not exceed the dimensions called for by the Snyder-Graf method. The article describes development of a homogram for microscope enlargements from 400 to 1000X on the basis of a 63.5mm section. The homogram is used for determining the number and average nominal diameter of an austenite granule. An enlargement of 800-1000X is judged to be preferable for determining the number of austenite granules. In tests at a number of special steel plants, the homogram and approximations were shown to be effective in achieving the new GOST standards by direct comparison with the GOST scales after magnification. In 3.7% of the tested steels, granules were smaller than standard, while in 1.3% they were larger. Where there is disagreement, or where metal for export is involved, the Snyder-Graf method is preferred as more objective.  
 [39-12131/12955]

UDC 539.2

## STRUCTURE AND PROPERTIES OF Kh18N10T STEEL AFTER ALTERNATING TORSION AT -196°C

Kiev PROBLEMY PROCHNOSTI in Russian No 9, Sep 85 (manuscript received  
 8 Sep 85) pp 45-47

GINDIN, I. I., NETESOV, V. M. and STAROLAT, M. P., Physical-Technical Institute, UkSSR Academy of Sciences, Kharkov

[Abstract] Earlier reports showed that alternating torsion at -196°C in the macro-elastic deformation zone intensified martensite gamma-alpha phase conversion in Kh18N10T steel, but complete conversion did not occur. The present article reports on further study of the effects of alternating torsion on dislocational structure evolution and rearrangement of the crystal lattice in various strata, as well as its effects on relaxational stability. Cylindrical specimens with a length of 30 mm and a diameter of 3 mm were hardened at 1100°C in water, then studied under alternating torsion. Results showed that up to 250 cycles, various structural zones formed in the test steel. The central layers consisted of residual austenite with some increase in dislocations. The surface zone contained epsilon-plates with alpha-martensite. Deformation capacity was dependent on the volume of martensite in the residual austenite. References 5: all Russian.  
 [49-12131/12955]

## DEPENDENCE OF FORMATION OF STRUCTURALLY FREE CEMENTITE IN STEEL ON CARBON, CHROMIUM, MANGANESE AND SILICON CONCENTRATIONS

Moscow IZVESTIYA AKADEMII NAUK SSSR: METALLY in Russian No 5, Sep-Oct 85  
(manuscript received 5 May 84) pp 90-93

UZLOV, I. G., PARUSOV, V. V., OLEYNIK, V. A., SIVAK, A. I. and SHMELEV, Yu. S.,  
Dnepropetrovsk

[Abstract] An experimental study of structurally free cementite in various steels was made, for the purpose of determining the dependence of its formation on the concentrations of C, Cr, Mn, Si as well as on the size of austenite grains. Recalescence during phase transformations was taken into account; this results from poor heat transfer during cooling after heat treatment and therefore causes formation of more structurally free cementite in factory samples than in laboratory specimens of hot-rolled carbon steel. The experiment examined 1.5 mm thick strips of plain carbon steels with 0.13-0.40% C (grades St.10, St.20, St.35), carbon steels with 0.15-0.39% C + 0.84-0.98% Cr (grades 15Kh, 20Kh, 40Kh), and carbon steels with 0.15-0.34% C + 1.08-1.00% Mn + 0.93-0.76% Si (grades 15GS, 35GS). They were austenized in a furnace at 950°C for 20 min. For better correlation of factory and laboratory cooling processes, recalescence was simulated by treatment of specimens in salt bath according to the sequence 950°C → 680°C + heating to 705°C at 2.5°C/min → cooling in air. Increasing the carbon concentration in plain carbon steels was found to first enlarge and then diminish the cementite grains to their complete disappearance in hypoeutectoid steel, in relation to the amount of excess ferrite and the corresponding solubility limit for carbon in iron. Addition of carbon and chromium was found to decrease the proneness to formation of structurally free cementite. Silicon lowers the solubility of carbon in gamma iron, while silicon and manganese together inhibit diffusion of carbon in austenite. There is less excess ferrite in 35GS steel than in 15GS steel. Under otherwise same conditions, enlargement of austenite grains causes enlargement of structurally free cementite grains. References 10: all Russian.  
[45-2415/12955]

UDC 621.039.53+537.533.35

## FORMATION OF RADIATIVE VOIDS IN Kh12G14N4Yu2M AUSTENITIC STEEL DURING BOMBARDMENT IN A HIGH-VOLTAGE ELECTRON MICROSCOPE

Moscow IZVESTIYA AKADEMII NAUK SSSR: METALLY in Russian No 5, Sep-Oct 85  
(manuscript received 24 Sep 84) pp 107-114

KANTOR, M. M., KOLOTINSKIY, V. N. and BANNYKH, O. A., Moscow

[Abstract] A study of K12G14N4Yu2M heat-resistant steel was made, for the purpose of determining the effect of its bombardment by high-energy electrons

at high temperatures on the formation of voids. An ingot weighing 150 kg and containing 0.08% C+ 12% Cr+ 14% Mn+ 4% Ni+ 0.5% Mo+ 1.4% Al+ 0.6% Si+ 0.03% S+ 0.03% P was founded in an induction furnace and then forged into a round bar 22 mm in diameter. Some specimens cut from this bar were austenitized and cold rolled to either 5% or 10% reduction. All specimens were bombarded with electrons in a JEM 1000 kV electron microscope and simultaneously heated, after having been polished electrolytically with a 5% HCl+ 95% glacial  $C_2H_4O_2$  mixture at room temperature. The electron flux intensity, measured with a Faraday cylinder, was  $10^{10}$  el/( $cm^2 \cdot s$ ) and the residual pressure in the microscope tube was maintained at approximately  $2 \cdot 10^{-4}$  Pa. The electron diffractograms have revealed a swelling of the steel at 400°C, most intensely after austenitization. Cold deformation prior to electron bombardment was found to reduce the swelling rate, with more deformation resulting in less swelling. The swelling rate was also found to increase at a decreasing rate with increasing electron dose and then to decrease with the electron dose exceeding  $2.5 \cdot 10^{23}$  el/ $cm^2$ , enlargement of initial voids rather than formation of new ones being the principal swelling mechanism. Bombardment at 500°C was found to result in isothermal breakup of the austenite with the latter becoming depleted of its swelling-inhibitor components and with attendant precipitation of  $M_{23}C_6$  metal carbides. Accordingly, stability of the austenite under high-energy high-temperature electron bombardment is the main requisite for adequate swelling resistance of this steel. References 16: 6 Russian, 10 Western (1 in Russian translation). [45-2415/12955]

UDC 532.593:539.213

# PRODUCTION AND STUDY OF STRUCTURE OF BULK AMORPHOUS FERROMAGNETIC ALLOY $Co_{58}Ni_{10}Fe_5B_{16}Si_{11}$

Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 284, No 4, Oct 85  
 (manuscript received 4 Dec 84) pp 854-857

ISKHAKOV, R. S., KIRKO, V. I., KUZOVNIKOV, A. A., BALAYEV, A. D., POPOV, G. V., and OVCHAROV, V. P., Institute of Physics imeni L. V. Kirenskiy, Siberian Department USSR Academy of Sciences, Krasnoyarsk

[Abstract] The problem of producing bulk homogeneous products from amorphous alloys is an important one. The present article is a short exposition of the "technological chain" for producing a bulk ferromagnetic alloy  $Co_{58}Ni_{10}Fe_5B_{16}Si_{11}$  by the explosion pressing method. A strip of alloy was first formed by rapid hardening from the melt, followed by annealing at 450°C for 1 hour, grinding of the strip into powder and finally, explosion pressing. Variable parameters in the method are the rate of the shock wave, the crystallization temperature of the initial amorphous alloy and the powder granule dimensions. Various measurements using X-ray diffraction, the calorimetric method, microhardness measurement and magnetostructural analysis showed, inter alia, that in compacting the amorphous alloy undergoes fundamental changes that alter inter-atomic distances. Local anisotropy was manifested in the ferromagnetic structure. References 6: all Russian. [52-12131/12955]

## NON-FERROUS METALS AND ALLOYS: BRAZES AND SOLDERS

### SAYANSKIY ALUMINUM IN PRODUCTION

Moscow SOTSIALISTICHESKAYA INDUSTRIYA in Russian 8 Sep 85 p 1

[Article by G. Smirnova]

[Test] A long-awaited event has taken place at the construction of the Sayanskiy Aluminum Plant--the State Commission has signed the statement of acceptance of the first section. The builders have turned over the "turn-key" project without any deficiencies whatsoever.

It was not easy to achieve this; significant distortions in the distribution of resources and funds permitted by the USSR Mintsvetmet [Ministry of Non-ferrous Metallurgy] and the USSR Mintyazhstroy [Ministry of Heavy and Transport Machine Building] hindered the work in previous years.

Many tasks were so difficult--said O. Ashirov, Manager of the Sayanallyumintyazhstroy trust,--that they seemed insoluble. But when the importance of these tasks was explained to the brigades, they found ways to solve them.

The names of the leading brigade leaders are on everyone's lips today. And especially many talk about the labor contribution of the integrated brigade of Viktor Fedorov. Three years ago this group emerged as the initiator of a competition for the right to participate in the startup of the first electrolysis unit (korpus) and it emerged the victor. The brigade leader with his associates raised the pennant "Glory to labor". His brigade deserved the highest appreciation; you see, it began a start-to-finish contract (skvoznoy podryad) and by its own efforts assimilated more than 1.5 million per year. Other groups followed after them. Such as the brigade of Mukharyam Badykov. Because of this, the Sayanallyumintyazhstroy trust has, since the beginning of the year, substantially surpassed the plans for capital investment assimilation.

The principled criticism of M. S. GORBACHEV in his address to the construction workers of the kray caused the builders of the aluminum plant to make greater demands of themselves and of their associates. And here is the result--the start-up complex, which included 67 projects valued at a quarter of a billion rubles, is ready. The metallurgists have begun produce of the planned aluminum. The head plant metallurgist B. Sibirtsev remarked with satisfaction: "The metal we are producing is of good quality. I am confident that we will quickly master the technology and by the opening of the party congress we will put out tens of tons of production beyond the plan."

The technology at the new plant differs from that in other similar enterprises. Of course, it is more interesting to operate on new equipment, but the troubles during the start-up are greater. For example, the Sayan electrolyzers are equipped with automatic feed, which does not show its best side. Even experienced workers are in a quandry: automatic equipment has been installed, but much manual operation is necessary. There is something here that the designers from VAMI All-Union Scientific Research and Planning Institute of the Aluminum, Manganese and Electrode Industry did not completely think through.

During construction of the plant specialists found many new advanced solutions. One of the main ones is the inclusion in the electrolysis unit of a reserve of extra capacity for expanding production. They plan, at the beginning of the next five-year plan, to start up an experimental section at the plant to develop fundamentally new technology. And the famous construction brigade of V. Fedorov is already assigned to begin the construction of this section.

12863/12955

CSO: 1842/26

## IGNITION OF TITANIUM UNDER THE INFLUENCE OF INTENSIVE RADIATION

Leningrad ZHURNAL TEKHNIЧЕСКОY FIZIKI in Russian Vol 55, No 8, Aug 85  
(manuscript received 10 Oct 84) pp 1576-1581

POYUROVSKAYA, I. Ye., Odessa State University imeni I. I. Mechnikov

[Abstract] A study is made of the ignition of titanium when exposed to pulses of laser radiation. The minimum duration of the laser pulses required to ignite titanium with various values of spot radius, plate thickness and radiation intensity of the center of the spot is calculated. Subsequent propagation of the combustion front and movement of the melt were not analyzed. References 6: all Russian  
[35-6508/12955]

UDC 669.343

## INTRODUCTION OF HIGH-PRODUCTIVITY EQUIPMENT FOR CONTINUOUS SMELTING OF CATHODE COPPER

Moscow TSVETNYYE METALLY in Russian No 9, Sep 85 pp 20-22

MENDELEV, I. S.

[Abstract] A new facility has been developed by the Special Design Office for Nonferrous Metallurgy and others for smelting cathode copper. The equipment is designed for a continuous process with high productivity. It consists of a shaft furnace with a charge hole in the movable top and with a chimney, a cyclone chamber for burning fuel gas, a gas and air injection system with gas collector and air collector, a trough, and a water-cooled cathode chopper. The cyclone chamber is the most critical component, designed for high heat loads of  $(40-120) \cdot 10^6 \text{ kJ}/(\text{m}^3 \cdot \text{h})$  in a compact configuration so as to ensure efficient combustion. The stack of raw cathodes is loaded into an elevator, hoisted onto a hopper, and dropped into the furnace through the charge hole. The molten copper flows down a chute into a mixer and from there through a set of chutes into ladles for being poured into molds on a rotating turret. Processing the copper at  $1120-1180^\circ\text{C}$  in this equipment yields a high-quality product without requiring oxidation and reduction, produces only small amounts of slag with little loss of metal in slag and in fumes, is very fuel efficient, and yields adequately desulfurized copper even from inadequately preprocessed raw cathode stock. The furnace set is easily started within 60-90 min and easily shut down within 5-10 min, is easily removed for overhaul and then easily reinstalled. A small volume of lining is required, which also greatly facilitates any repair work.  
[34-3215/12955]



## FAGGOTING PRODUCTS OF NONFERROUS METALLURGY

Moscow TSVETNYYE METALLY in Russian No 9, Sep 85 pp 26-28

YEREMIN, M. N., BELETSKIY, G. V., PERELMAN, F. S., BURYLIN, P. B.,  
MASHEVICH, Ya. R. and NIKITIN, V. T.

[Abstract] A new shape of nonferrous metal ingot bars has been designed for efficacious faggoting and further processing. The principal idea is to dovetail the bars pairwise with both smooth surfaces on the outside and to stack the pairs in criss-cross fashion into an interlocked faggot. A faggot of aluminum or aluminum alloy, for example, is tied with rolled wire of the same material, rather than with steel tape, to be ready for smelting as is. This eliminates the need for untying the faggot, cutting and removing the tape as well as further handling of the latter. Bars and faggots have been standardized for aluminum and aluminum alloys and modifications are being made for copper and copper alloys, zinc and zinc alloys, lead and lead alloys as required. All stacking, baling, and transporting operations have been designed for a maximum degree of standardization and automation. On a 100,000 t basis, labor productivity should increase by 300%. The production cost of ingot metals and copper cathodes, for instance, should be reduced by 3-10 rubles/t.

[34-2415/12955]

UDC 669.243.82+669.436+669.536

## TECHNOLOGY OF LEAD AND ZINC EXTRACTION FROM NICKEL PRODUCTION DUST

Moscow TSVETNYYE METALLY in Russian No 9, Sep 85 pp 31-33

NAVATANOVICH, M. L., ROMAZANOVA, I. I., SHALYGINA, Ye. M., ROZOV, Ye. V.  
and KALYUGA, S. N.

[Abstract] A new technology of lead and zinc extraction from nickel production dust has been developed, namely selective lixiviation of both metals with aqueous solution of  $\text{CaCl}_2$  from dust trapped in electric filters in nickel production plants according to the reaction  $\text{Ca}(\text{Pb}, \text{Zn})\text{Cl}_4 + \text{Ca}(\text{OH})_2 \rightarrow (\text{Pb}, \text{Zn})(\text{OH})_2 + 2\text{CaCl}_2$ . The technology is economically justified by the high Pb and Zn contents in the dust after purification of commercial nickel to the allowable Pb and Zn impurity levels. Lixiviation with  $400 \text{ g/dm}^3 \text{ CaCl}_2$  is followed by neutralization of the pulp to a pH= 4-4.5, transfer into  $\text{Cu}+\text{Fe}+\text{Ni}+\text{As}$  sediment, filtration, precipitation with milk of lime, and final filtration with recovery of recyclable  $\text{CaCl}_2$ . Dust is transported by a set of helical conveyors to a repulper, where it mixes with a  $\text{CaCl}_2$  solution heated in an enclosure to  $70^\circ\text{C}$ . Processing 1 ton of dust requires 200-275 kg  $\text{CaCl}_2$  and 100 kg  $\text{CaO}$  and also  $0.62\text{-}0.92 \text{ m}^3$  of conveyor belting. References 3: all Russian.

[34-2415/12955]

## PRODUCTS OF TIN REFINING FOR ARSENIC REMOVAL WITH CHROMIUM

Moscow TSVETNYYE METALLY in Russian No 9, Sep 85 pp 33-35

DYAKOV, V. Ye. and VARNEK, V. A.

[Abstract] Raw tin is usually purified of arsenic by addition of aluminum to the melt. However, aluminum arsenide forming in the process reacts with moist air and produces a highly toxic gas ( $\text{AsH}_3$ ). A much safer method of refining raw tin is doing it with chromium, the nonvolatile two compounds  $\text{CrAs}$  and  $\text{Cr}_2\text{As}$  being removable with the tailings. A chemical and phase analysis by the method of nuclear-gamma resonance, on the  $^{119}\text{Sn}$  nucleus, has revealed all other products of tin-chromium interaction. Specimens of tin containing 2.77% As were refined by adding 6% Cr ligatures to the melt. After centrifugation at  $350^\circ\text{C}$ , 100 g samples were quantitatively analyzed by the weighing method. The %As extracted was found to increase with increasing doses of chromium and then remain constant upon further addition of chromium beyond the stoichiometric Cr:As ratio. Mossbauer spectra were obtained at room temperature with an MS-10K spectrometer and a  $\text{Ba}^{119}\text{SnO}_3$  radiation source. The spectra of  $^{119}\text{Sn}$   $\beta$ -Sn in a chromium ligature were found to be similar to those of  $^{119}\text{Sn}$   $\beta$ -Sn in a titanium ligature, indicating formation of an analogous Sn-Cr phase. This phase is evidently formed by tin with excess chromium, after almost all arsenic has been extracted. References 6: 2 Russian, 4 Western (2 in Russian translation). [34-2415/12955]

UDC 669.721.372.66.093.6

## REDUCING ENERGY LOSSES AND INTENSIFYING DEHYDRATION OF SYNTHETIC CARNALLITE IN FLUIDIZED-BED KILNS

Moscow TSVETNYYE METALLY in Russian No 9, Sep 85 pp 51-53

REZNIKOV, I. L., SANDLER, G. Yu., SVIDLO, V. P. and KRAYUKHIN, A. B.

[Abstract] A fluidized-bed kiln has been developed for dehydration of synthetic carnallite prior to its electrolysis. Synthetic carnallite is first produced by desulfatization of natural chloride-sulfate salts and their subsequent crystallization into  $\text{KCl} \cdot \text{MgCl}_2 \cdot 6\text{H}_2\text{O}$ . The tripartite kiln consists of a loading compartment followed by two successive processing chambers with gas distributor grids. It differs from the conventional kiln for reprocessing enriched recrystallized natural carnallite by being taller with taller baffles and with a larger surface area of the gas distributor grids. Its basic version has been further modified for better fuel economy and for intensification of the dehydration process. Essentially, the loading compartment has been lengthened: in one version by shortening the first fluidized-bed chamber only and in the second version by shortening both fluidized-bed

chambers. One major drawback of this modification is nonuniform spreading of carnallite over the surface of the fluidized beds by the stirrer and thus a higher probability of carnallite lumps falling on the hot gas distributor grids which they can clog up while melting. Both versions have been otherwise designed for thermodynamically optimum performance, with the temperature of flue gases exhausted from the first chamber not higher than optimum and the temperature under the grids not lower than optimum so as not lower the thermal efficiency. Extra energy can be saved by lowering the mean temperature of the carnallite in the beds, for which various methods are available such as dehumidification of the coolant, air-cooling of the gas distributor grids, and utilization of the heat of flue gases. References 6: all Russian. [34-2415/12955]

UDC 620.178.311.4(088.8)

#### PREDICTING FATIGUE LIMIT OF D16 ALUMINUM ALLOY

Moscow TSVETNYYE METALLY in Russian No 9, Sep 85 pp 83-85

MURATOV, V. S.

[Abstract] Since aluminum alloys become structurally unstable during zonal aging under load, it is difficult to predict their fatigue limit directly either from their static mechanical characteristics or on the basis of a physical model. In search for a fast and reliable method of predicting it, pressed D16 aluminum alloy was chosen as representative material in this category and specimens of it were tested for ultimate strength, 0.2% yield strength, Vickers hardness, and electrical resistance under a cyclic load. They had been pretreated in three ways, standard heat treatment with quenching from 500°C followed by natural aging (No 1) or special deformation-heat treatment with accelerated water-cooling after deformation and three quenches followed either by natural aging (No 2) or by artificial aging in 90 min at 190°C (No 3). The results of endurance tests based on  $5 \cdot 10^5$  cycles, with monitoring of the hardness at the recovery temperature (250-260°C) during intermediate soaking periods (45-80 s), reveal the kinetics of structural changes and mechanical properties. They indicate that the second special treatment, resulting in the smallest relative decrease of hardness from the state of zonal aging to the state of recovery  $= (HV_z - HV_r)/HV_z = 0.15$ , will impart the longest life to D16 aluminum alloy. The procedure of fatigue testing with intermittent recovery and hardness measurement over a 60 s period, as arbitrary reference, is both fast and reliable without requiring intricate specimens and expensive test equipment. References 8: all Russian. [34-2415/12955]

## SOME PROPERTIES OF WC+Co POWDER MIXTURES PRODUCED FROM W-Co SALTS

Moscow TSVETNYYE METALLY in Russian No 9, Sep 85 pp 86-88

VASKEVICH, N. K., SENCHIKHIN, V. K., TRETYAKOV, V. I. and NIKITINA, Z. V.

[Abstract] The technology of producing chemical WC+ Co powder mixtures from ammonium-cobalt paratungstenate was studied, for the purpose of tracking the reactions involved in the process and the factors determining the basic properties of such mixtures. Decomposition of the salt has been found to result in a  $\text{CoWO}_4 + \text{WO}_3$  mixture, which by reduction with hydrogen and carbida-tion with methane converts into a  $\text{Co}_7\text{W}_6$  and WC+ Co mixture. The components of this mixture were identified and quantitatively determined on x-ray grams in an RKD camera, using a Co-radiation source and an Fe-filter; their crystal structure was examined in a DRON-1 x-ray diffractometer with an Fe  $K_\alpha$  source. The data reveal a two-phase powder of a WC+ 6% Co composition, which indicates up to 6% bound carbon and thus more than the theoretical 5.74% chemically bound one. The additional carbon is evidently dissolved in cobalt. Micro-structural examination under a scanning electron microscope with x300 magnifi-cation revealed agglomeration of submicron grains into cuboidal clusters 5-30  $\mu\text{m}$  in size, easily crushed so that powders of any grain size within the 0.5-3.5  $\mu\text{m}$  range can be produced. According to the results of this study, the Co component of chemical WC+ Co mixtures contains a solid solution of tungsten and carbon in cobalt rather than pure metallic cobalt contained in mechanical WC+ Co mixtures and their WC component has a less than perfect crystal lattice. Chemical mixtures are more homogeneous than mechanical ones, according to the results of x-ray microspectral analysis with an MS-46 microspectrometer. Measurements under the electron microscope were made by K. S. Chernyavskiy. Measurements with the microspectrometer were made by Yu. V. Gostev. References 4: all Russian.

[34-2415/12955]

## REDUCTION OF COBALT AND NICKEL OXIDES BY HYDROCARBONS IN A HIGH-ENTHALPY GAS STREAM

Kiev POROSHKOVAYA METALLURGIYA in Russian No 9, Sep 85 (manuscript received 28 Jul 83) pp 5-8

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[Abstract] A method is proposed of producing Co and Ni powders by reducing their oxides with propane in a high-enthalpy N stream. Propane is used instead of H or CO to prevent reoxidation of the metal vapors. The advantages

of N as a heat carrier are: reduced explosion hazard, greater electric-arc-heater life and higher thermal efficiency. In addition, this approach has certain technological advantages for full-scale production. The raw materials were pure-grade oxide powders of Co (III) and Ni (III). The reducing agent was industrial-grade propane (85-90 % pure). The N was commercially pure with no more than a 0.2 vol. % admixture of oxygen. The oxides were reduced in a multisection, water-cooled, graphite-lined cylindrical reactor with three EDP-104A electric-arc heaters. Reduction was carried out in gas flows at temperatures of 5600, 5200, 5000, 4200 and 2000 K with initial powder particle size of 100  $\mu\text{m}$ . The changes in chemical composition of Co and Ni powders during annealing in undessicated H were studied. The following two-stage process is recommended for producing Co and Ni powders with particle sizes of 0.05-0.06  $\mu\text{m}$ : reduction by propane in a N stream at temperatures of 4200-2000 K and with reagents in stoichiometric ratio; refining annealing of the powders in H for 1.5 hours at 873 K (Co) and 973 K (Ni). The powders obtained can be successfully used for manufacturing metal filters, contact-device elements etc. References: 8: all Russian.  
[46-12595/12955]

UDC 621.762.5

#### DISTINGUISHING FEATURES OF THE SINTERING OF BIPOROUS MOLYBDENUM-COPPER PSEUDOALLOYS

Kiev POROSHKOVAYA METALLURGIYA in Russian No 9, Sep 85 (manuscript received 27 Nov 84) pp 11-14

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[Abstract] The interaction of macro- and microporosity was studied during the sintering of biporous Mo-30 vol. % Cu pseudoalloy in H. Solid-phase sintering (SPS) at 1273 K and liquid-phase sintering (LPS) at 1473 K of the biporous pseudoalloy were compared. Microshrinkage, the shrinkage of sections of biporous material with small pores, was much greater during LPS and increased with an increase in microporosity. The process of localized compaction at the macroporosity level was studied. The enlargement of macropores during sintering of micropores was found to be determined by zonal isolation; processes occurring at the microporosity level determine this material's structural characteristics at the macroporosity level. The distinguishing features of the SPS and LPS processes were determined. The sintering efficiencies of SPS and LPS of material with varying degrees of porosity were studied and compared. References 10: 9 Russian, 1 Western.  
[46-12595/12955]

## INTERACTION OF HAFNIUM NITRIDE WITH MOLYBDENUM, TUNGSTEN AND TANTALUM

Kiev POROSHKOVAYA METALLURGIYA in Russian No 9, Sep 85 (manuscript received 12 Apr 81) pp 58-64

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[Abstract] A study was made of quasibinary HfN-Me' (Me' = Mo, Ta, W) eutectic systems, for which equilibrium diagrams were constructed. X-ray and metallographic analysis were used. HfN-Mo and HfN-W were sintered in N, while HfN-Ta was sintered in Ar. Direct application of electricity was used to melt, heat treat and anneal the specimens. The eutectics were found to be (wt.%) 25 HfN-75 Mo, 45 HfN-55 W, and 35 HfN-65 Ta, with respective eutectic temperatures of  $3680 \pm 50$ ,  $3070 \pm 60$  and  $2950 \pm 50$  K. The lattice parameters and microhardnesses were determined for the different solid solutions. Only two phases--HaN and Me'--were found. The relative solid-state stability as a function of the statistical weight of stable  $d^5$  atomic configurations of HfN-Me' systems was compared with that of  $HfB_2$ -Me' and  $HfC$ -Me' systems. It is shown that the relative solid-state stability of  $HfX$ -Me' systems increases in the following sequence: boride-carbide-nitride; i. e. with the increased probability of forming an  $s^2p^6$  electron configuration in the non-metal atomic sphere. The results show that an analysis of the distinguishing structural features of  $Me^{IV}N$ -Me' systems should be based on the following criteria: 1) stability of simultaneous phases in the solid state and 2) G. V. Samsonov's principles of electron configuration localization in a solid body. References 19: all Russian.  
[46-12595/12955]

UDC 539.4

STRENGTH AND PLASTICITY CHARACTERISTICS OF TUNGSTEN AND ITS ALLOYS. II. ONE-SECOND CREEP AND LONG-TIME STRENGTH BASED ON  $1 \cdot 10^4$  SEC

Kiev POROSHKOVAYA METALLURGIYA in Russian No 9, Sep 85 (manuscript submitted 12 Sep 84) pp 76-84

BUKHANOVSKIY, V. V., KHARCHENKO, V. K., KRAVCHENKO, V. S., OLSHANSKIY, A. B., GOLOVIN, S. A. and NIKOLSKIY, V. N., Institute of Strength Problems, UkSSR Academy of Sciences

[Abstract] The creep and long-time strength (based on  $1 \cdot 10^4$  sec) characteristics of commercially pure W and precipitation-hardened alloys  $W-Y_2O_3-HfO_2$  and  $W-Y_2O_3-(HfO_2-Cu)$  produced by powder-metallurgical methods at temperatures of 1500, 1750, 2000 and 2500°C were investigated and analyzed. Regression analysis was used to obtain empirical equations describing the steady-state creep rate and time until fracture as functions of the applied stresses at

at the test temperatures. The  $\text{HfO}_2$  and Y particles greatly reduced the long-time strength of W at temperatures above 2000°C. The presence of these particles in W initiates the critical recrystallization stage during creep, increasing the creep rate and decreasing the service life. The structural features of W-alloy fractures were fractographically investigated.

References 1: all Russian.

[46-12595/12955]

UDC 620.184.6:539.388.1:669.24

#### MICROMECHANISMS OF FATIGUE CRACK GROWTH ALONG GRANULAR BOUNDARIES IN COARSE-GRAIN NICKEL

Kiev PROBLEMY PROCHNOSTI in Russian No 9, Sep 85 (manuscript received 10 Apr 84) pp 50-59

KRAMARENKO, I. V., KRASOVSKIY, A. Ya., LIKHACHEV, V. A. and VASILYEV, N. N., Institute of Strength Problems, Kiev, Leningrad

[Abstract] Various micromechanisms of fatigue failure form under cyclic loads. The types of failure are related to factors such as the type and microstructure of the material, loading and tension factors, crystalline structure and other parameters. Since earlier studies did not always take account of kinetic values, the present article reports on study of the development of fatigue cracks along granular boundaries in the model material, a coarse-grain nickel with near total purity. To prevent surface defects that accompany mechanical processing, an electric spark method was used for final polishing of the specimens. Tests were then made for acentric cyclic tension and various load factors. Results indicated that failure of the alloy occurred along granular boundaries and was of a brittle nature. Crack development and fractographic study using scanning and transmission electron microscopy further showed formation of ductile fatigue furrows and other relief signs of failure. As the shear component in cracking increased, reverse sliding in a direction perpendicular to the fatigue crack growth increased, while ductile grooving in the fractures decreased. Correlation was noted between macro- and micro-rates of cracking in the second segment of the kinetic diagram of fatigue failure. References 13: 8 Russian, 5 Western.

[49-12131/12955]



## EFFECT OF TITANIUM AND NIOBIUM ON SOLUBILITY OF CARBON IN Kh15Yu5 ALLOYS AND ON THEIR HIGH-TEMPERATURE OXIDATION

Moscow IZVESTIYA AKADEMII NAUK SSSR: METALLY in Russian No 5, Sep-Oct 85  
(manuscript received 11 Mar 84) pp 164-168

GOROKHOVA, N. A., SUVOROVA, S. O. and SARRAK, V. I., Moscow

[Abstract] An experimental study of Kh15Yu5 high-temperature alloys was made, for the purpose of determining the dependence of their life and "tenacity" on the carbon content in solid solution as well as the dependence of that carbon concentration the amount of added titanium and niobium. A basic Fe-Cr-Al alloy (0.130% C+ 14.32% Cr+ 5.40% Al) as well as six alloys also containing titanium (0.12-0.81% Ti) and one alloy containing 0.26% Ti+ 0.21% Nb, with the aluminum content slightly different in each but the chromium content almost the same, were produced in a vacuum furnace. They were heat treated at 1250°C for 1 h and quenched in water, to ensure a homogeneous structure and a consistent grain size. The solubility of carbon in solid solution was determined on the basis of measurements of internal friction and its temperature dependence. Wire specimens 0.8 mm in diameter were vibrated at a frequency of 1 Hz in a relaxator, an inverse torsion pendulum, in a constant magnetic field of 25 kA/m intensity. The life of these specimens was measured at 1150°C, a temperature 150°C higher than recommended for Kh15Yu5 alloys in electric furnaces. They were tested for tenacity by cyclic heating to 1150°C and cooling to room temperature twice a minute. The results reveal that, after quenching from 1350°C, internal friction and thus carbon concentration peak sharply within the 260-280°C temperature range unaffected by the presence of nitrogen. The temperature dependence of carbon solubility indicates that the full solubility of 0.130% C in the plain Fe-Cr-Al alloy is reached at 1150°C. A phase analysis of this alloy has revealed the presence of iron-chromium carbides, whose formation is subsequently inhibited by addition of titanium or titanium and niobium forming their own carbides (also nitrides) thus lowering the carbon content. At the operating temperature of 1150°C, accordingly, carbon is fully dissolved in all Kh15Yu5 alloys. Addition of titanium or titanium and niobium therefore appreciably increases the tenacity of these alloys as well as their resistance to oxidation at high temperatures, their life thus lengthened in a direct relation to increase of the Ti/C ratio. The authors thank A. I. Gorshkov for testing the alloys and I. M. Plemyannikova for obtaining the data on their tenacity. References 12: 8 Russian, 4 Western (1 in Russian translation).  
[45-2415/12955]



UDC 622.341.2:621.921.33]:[658.567.1.666.11-404.2:666.974.2

REFRACTORY MASSES BASED ON SLAG-LIQUID GLASS BINDER

Dnepropetrovsk METALLURGICHESKAYA I GORNORUDNAYA PROMYSHLENNOST in Russian  
No 3, Jul-Sep 85 pp 53-54

SHPIRKO, N. V., DIBROV, G. D., Deceased, GANNIK, N. I. and CHUMAK, L. I.,  
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[Abstract] Results are presented from studies of the variation of the strength and phase composition of slag-liquid glass binder as a function of temperature from 200 to 1200°C. Specimens were made from metallic manganese slag (60%) and liquid glass (40%), or synthetic corundum slime (56%), metallic manganese slag (14%) and liquid glass (30%). The major minerals were found to be formed in the binders at 800-900°C. Thermal analysis can be used to determine the temperature of the formation of the minerals but does not indicate their type or the change in the strength characteristics of the binders as a function of temperature. To determine changes in strength and its relationship to mineralogical composition, specimens were heated to 200-1200°C for 100 hours to assure good equilibrium of phase composition, after which they were reheated and tensile tested. The refractory concrete suggested can be recommended for lining of units to operate at 1250-1300°C. Heat insulating products can be made which have a density of 0.35-0.4 kg/l, a strength of 0.5-0.8 MPa, and can withstand temperatures up to 1200°C.

References 3: all Russian.

[42-6508/12955]

## FORMATION OF POLYCRYSTAL MICROSTRUCTURE IN PROCESS OF SINTERING DIAMOND POWDERS DURING DYNAMIC SYNTHESIS

Moscow DOKLADY AKADEMII NAUK SSSR Vol 284, No 4, Oct 85 (manuscript received 4 Feb 85) pp 860-863

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[Abstract] The high mechanical and cutting properties of superhard materials based on dense boron nitride modifications are determined by the high-dispersion structure of granules ranging from microscopic sizes to 1-3 mcm. The present article reports on structure formation in such a highly dispersed superhard material produced by sintering diamond powder under high pressure and temperature. Structure was determined by X-ray and illuminating electron microscopy. The initial diamond powder contained ca. 40% lonsdalite and flakes with a surface of 1-3 mcm and a thickness of 0.05-0.07 mcm. Electron microscope studies with a dark field made it possible to reveal the disoriented substructure and its morphological relationship to the phase composition. The flakes containing largely lonsdalite were particularly marked by this disorientation. During compression into polycrystals, the granular structure of the diamond-lonsdalite particles was pulverized and the granular disorientation increased. Sub-granular structure during hot compacting changed as the phase transition from lonsdalite to diamond occurred. Hot deformation, fragmentation, phase conversion and recrystallization were involved in the formation of the high-dispersion granular structure of superhard materials based on high-pressure carbon and boron nitride.

References 11: 10 Russian, 1 Western.

[52-12131/12955]

## PREPARATION

### ENGINEERING CENTERS ACCELERATE IMPLEMENTATION OF SCIENTIFIC ADVANCES

Moscow SOTSIALISTICHESKAYA INDUSTRIYA in Russian 3 Aug 85 p 2

[Article by N. Novikov, Academician, UkSSR; Director, Institute of Superhard Materials, UkSSR]

[Text] The engineering centers created at the Institute of Electric Welding imeni E. O. Paton, the Institute of Cybernetics imeni V. M. Glushkov, and our Institute of Superhard Materials, have stimulated much interest among our colleagues. The need for such organizations was prompted by the experience of past years. No one previously disputed the fact that qualitative changes in production and pronounced increases in labor productivity are possible only through extensive and dynamic assimilation of the results of fundamental research. However, in practice, we every now and then encountered instances when important developments embodying these results were assimilated by industry with intolerable slowness.

It is just such sad experience that led to the conclusion that it was time to change the concept of the "end product" of academic science. It is naive to count on the rapid introduction of an idea alone, even if it is very promising, because often the production workers are simply not ready to grasp it. On the other hand, the chances of success increase sharply if the institute can offer technical documentation, even better--an experimental model, and still better yet--a finished product or technology.

To provide industry with such an "end product", some years back our academy formed scientific-technical groups [kompleks] based on leading institutes which are now operating successfully. These groups comprise such elements as design and technological offices, experimental production units, and an experimental plant, in addition to the research nucleus, which is the institute proper. And sometimes there is also a training center for retraining production workers.

But, as it turned out, in a number of cases even such a structure requires improvement. Whenever there is an idea promising appreciable results in several sectors and whenever it is necessary to achieve a breakthrough in some important direction, it is necessary to have the capability of gathering all resources into one concentrated force. This is achieved within our groups by directly assigning a portion of each of the above-mentioned elements to the researchers solving a specific problem. Such problem-oriented structures have been designated as engineering centers.

The question might come up as to why it was necessary to seek new organizational forms, if an institute in the past successfully solved important problems? Well, our collective has a major role in the fact that the volume and rate of using industrial diamonds in our country is significantly greater than abroad. The extensive production of synthetic diamonds, polycrystals, composites of various superhard materials, and more than 5,000 standard sizes of a tool based on them has been organized. This tool was created on the basis of institute developments and has found application in more than 10,000 of our enterprises. There are significant deliveries to the socialist countries, to the USA, Canada, Japan, Italy, and Switzerland.

But for the institute all of this is a stage already traversed. On the basis of the results of fundamental research and during the present Five-Year Plan alone we have been successful in producing high-strength and heat resistant diamonds, and kibar crystals and in creating 100 new tools for grinding, cutting, drilling, and complex shaping. Most of these are qualitatively changing the processes of manufacturing machine parts and construction components. For example, for frustum honing of internal-combustion engine cylinders the machining productivity increased by two-fold and the wear resistance of the surface, by five-fold. And for the reprocessing of wood and waste-paper by-products and other forms of secondary raw materials, a new tool was, in terms of productivity and energy savings, 50-100 times more effective than that previously used.

One would think, what can be the relationship between our materials and the problems of electronic equipment? As is known, such semiconductor materials as silicon, germanium, and gallium arsenide have been used for a long time. But the fact is that for many of the instruments and devices based on them, the parameters have for practical purposes reached the limits of the possible. There is a need for new semiconductor materials, a role which at present has been successfully laid claim to by ... a new generation of synthetic diamonds.

The industrial-experimental technology for the synthesis of such diamonds and high heat-conducting crystals was created by us for the first in world practice and is protected by patents in a number of highly developed countries. The first model of semiconductor diamond-based devices, for which there are no analogs abroad, were constructed and tested successfully. At the present time, the concern is not only that these developments be broadly introduced, but also that the problems be solved in the shortest possible time.

Whenever the question is raised in that way, it must be recognized that a new material or tool can quickly acquire rights of citizenship if the technology for their use and the entire system of equipment embodying it are developed simultaneously. We can say that such a system for manufacturing precision parts was successfully developed by our scientists jointly with the SKTB [special design technological and office] specialists and the experimental plant during the present five-year plan. The system increases productivity a 100-fold in comparison with existing equipment. To achieve such results, new tools were not the only things needed -- the machine-tool "base" itself was changed significantly and special electronic measurement devices and control equipment were developed.

This example shows the effectiveness, from the viewpoint of the rates of technical progress, of combining within one organization all four principal stages of innovation: research, design, manufacture of experimental models, and testing. But there are complications here: practically all the research sections and laboratories of the institute lay claim to the participation of the SKTB and the experimental plant. To which of them should we give preference if there are about 90 of them in our work plan? All are important, necessary, and show promise ...

Here then arises the need for organizing engineering centers which permit one to concentrate resources in a decisive direction. For our institute that direction was the production of powerful press and heating equipment. The interests of most of the research departments and laboratories are focused on precisely that equipment; it is only with the help of superhigh pressures and temperatures that it is possible to produce the new superhard materials. Consequently, the engineering center set up at our institute has been given the symbolic name "Press".

This center consists of 12 candidates of science, 40 scientific associates, and 60 designers and technologists. Its production unit is the nonstandard equipment section of our experimental plant which is staffed by skilled specialists and workers. This combination enables the engineering center to effectively carry on the work of fundamental research by converting its results into specific developments and experimental models of equipment. Moreover, the work is organized in such a way as to minimize the participation of the researchers in the implementation and to reserve their efforts for the solving of new problems. At the same time the engineering center serves as a connecting link that insures the spread of new developments into general practice. For this it interacts with the enterprises, NII [scientific research institutes], and KB [design offices] of the appropriate ministries. In the given case -- with Minstankoprom [Ministry of the Machine Tool and Tool Building Industry] and Mintyazhmash [Ministry of Heavy and Transport Machine Building].

The engineering centers are taking their first steps. But already problems that hinder their work are appearing. The new units, work on a self-supporting basis (khozraschet). So, they need to be allocated working capital. We have substantial withholdings available, but, unfortunately, we cannot use them with a free hand. This includes those for providing bonuses to workers in proportion to their contribution.

The new form of interaction between science and practice also needs a new approach. Especially when the topic of discussion is the production base. The work of the Institute of Electric Welding imeni Ye. O. Paton and its associates clearly shows that the experimental plant of an academic scientific-technical group is an extremely profitable enterprise. Its output in the form of experimental models, first batches of a new material, or first experimental-industrial installations go to an enterprise immediately and yields a significant savings. For example, the economic effect from using the output of our plant is, as a rule, 3-5 times greater than the costs for its manufacture. It makes good sense to build up the number and capacities of

of such enterprises which support the work of the engineering centers of academic sciences. But above all -- they permit the rapid acceleration of the introduction of new equipment and technology that are capable of bringing about revolutionary improvements in production.

12863/12955

CSO: 1842/26

## BUREAUCRATIC PROBLEMS FOR POWDER METALLURGY DEVELOPMENT

Moscow PRAVDA in Russian 12 Oct 85 p 1

[Article by PRAVDA correspondent I. Novikov: "In the Range of Research" under the heading: "Potential Growth" with the inset: "Course: association with production. What powders can do if the barriers are eliminated."]

[Text] Minsk. The creation of new, strengthening materials for machine builders, the use of impulse loads for pressing powders, and welding by explosion,... This is only a partial list of the directions along which specialists of the Belorussian Scientific Production Association for Powder Metallurgy are conducting research. Many developments, having received a start in life here, already are known far beyond the limits of the republic. Another fact is noteworthy; upon emerging from the laboratories, the developments quickly receive a secure visa to the enterprises.

The Belorussian scientists working in the field of powder metallurgy however, always have adhered to a course of close association with industry. One can recollect, for instance, how, several years ago, united then in all only in one of the faculties of the republic's polytechnical institute, they persistently invited leaders of enterprises to various exhibitions and seminars which they conducted at their own laboratory, convinced them of the merits of the new technology, and how they assisted in the development of the first specialized production bays.

The researchers also thought about those who faced the assimilation of the promising technology later on. The graduates of their faculty who had the most initiative and were the most goal-seeking were trained for practical work at enterprises. How alert they were! Soon, BelAZ [Belorussian Motor Vehicle Plant], the Nesvizh department of Belcelkhoztekhnika [Belorussian Agricultural Equipment Association] and some Mogilev enterprises became interested in metal powders.

So it was quite recently. It is a different business now. A scientific production association has been created in which there is an NII [Scientific Research Institute] of powder metallurgy, a special design and technological bureau, an experimental production unit and a large plant in Molodechno besides. The first stage of this enterprise already has been put into operation. Later on, the plant will produce 10,000 tons a year of articles made from powders. In

the association, creative brigades made up of scientists, designers and the best workers have been developed. All this, of course, cannot but affect a future strengthening of the association of the researchers with the producers.

"The benefits of such an association are mutual" thinks the director of the Belorussian Republic's Scientific Production Association for Powder Metallurgy, Professor O. Roman. "Consider that under the leadership of Doctor of Technical Sciences P. Vityaz in collaboration with associates at the Institute of Heat and Mass Transfer of the BSSR Academy of Sciences a technology of permeable materials was developed. And on its basis, for the first time, the mass production of heat pipes is being developed. Or take another example. Millions of tons of gypsum went into dumps after several scores of pourings in the production of porcelain vessels. The same form made from powders sustains up to 3,000 pourings."

And, after the formation of the association, has the path of developments from idea to introduction into production been successfully shortened?

"Absolutely, it now has become shorter" answers Yu. Roman. "By our reckoning, shorter by a factor of more than two. Contributing to this in many ways is the fact that all subdivisions, subordinate to the general direction of the association, work according to a unified plan. And they have the same balance with the exception of the Molodechno plant for whom, as we were convinced, it is more convenient to solve operational economic problems independently. In fact, it is removed from the "staff" by many kilometers. In a word, there are improvements there, however, complete well-being is still far off."

What is interfering? One of the reasons the interlocutor names is equipment, frequently obsolete, which is furnished to the association by the USSR Ministry of the Machine Tool and Tool Building Industry. And to carry out the required operations on obsolete presses is an unrewarding pursuit. Or take the question of financing. The Scientific Production Association was created primarily to provide the enterprises of the republic with articles made from powders independent of departmental subordination. And 80 percent of the products of the association now are consumed in Belorussia. The Council of Ministers of the republic, however, to which it is directly subordinate, does not even have a budget item for machine building. Now, it falls to the leadership of the Scientific Production Association, literally, to fight through by various ways any detail of important matters, appealing all the way up to USSR Gosplan.

It should also be recognized that the very same machine building and tool building plants still are insufficiently interested in the effective utilization of the new technology. Some think: why petition for these powders if the planning organizations, which have provided the enterprise for the entire, let us say, five-year program with the usual metal or rolled stock have already taken care of this? The repair and mechanical plant of the Beloruskaliy [Belorussian Potassium?] Production Association behaves exactly in this way. Finally, not every new development is advantageous today to an enterprise manufacturing equipment. Thus, the direct profit from the operation of



electric motor commutators is above 7 million rubles. But the plant producing them gets nothing from this.

It is true that these difficulties in the Belorussian Scientific Production Organization for Powder Metallurgy, are considered temporary. Assuredly, with the passage of sufficient time, the barriers, economic and organizational, along the way to the introduction of the progressive technology will be eliminated. Consequently, here, they look to tomorrow with optimism. In particular, the specialists of the association plan by 1990 to increase the productive capacity of the Molodechno plant by 2 million tons.

9136

CSO: 1842/51

## EFFECTIVENESS OF COMBINED INFLUENCE OF LASER RADIATION ON METAL SURFACE

Leningrad ZHURNAL TEKHNIЧЕСКОY FIZIKI in Russian Vol 55, No 8, Aug 85  
(manuscript received 5 Sep 84) pp 1650-1652

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[Abstract] The purpose of this work was to study the effectiveness of the thermal influence of the radiation of a CO<sub>2</sub> laser on metals under conditions of forced ignition of an optical discharge near the surface. An electroionization CO<sub>2</sub> laser with an energy of up to 100 J per pulse and pulse length of 50-500 microseconds was used. Pulse shape was near rectangular. The radiation of the laser was focused by a 30 cm focal length lens on a spot about 3 mm in diameter. Targets were aluminum and copper specimens 1 x 1 x 5·10<sup>-2</sup> cm in size. The intensity of CO<sub>2</sub> laser radiation selected was below the threshold of optical breakdown near the target. Forced plasma ignition was achieved with an Nd laser pulse with an energy of about 0.1 J and duration of about 15 ms. The Nd laser pulse was delayed relative to the CO<sub>2</sub> laser pulse by about 10 microseconds. It was shown that forced ignition of the optical discharge plasma near the surface resulted in a significant increase in energy transmission to the target, particularly for targets with good reflectivity. References 4: 1 Russian, 3 Western.  
[35-6508/12955]

## IMPROVING COLLECTION AND UTILIZATION OF TAILINGS IN NONFERROUS METALS PRODUCTION ENTERPRISES

Moscow TSVETNYYE METALLY in Russian No 9, Sep 85 pp 116-117

TARASENKO, M. M. and DEMCHENKO, S. D.

[Abstract] An all-union scientific and technical seminar on improving the collection and utilization of tailings in nonferrous metals production enterprises was held in April 1985 by the USSR Ministry of Nonferrous Metallurgy under the auspices of the All-Union Scientific Research Institute of Secondary Nonferrous-Metals Production (UNIIP vtortsvetmet), with the participation of representatives from the industry's scientific research institutes and enterprises and specialists from both USSR and UkSSR Academies of Sciences, the USSR Ministry of the Construction Materials Industry and USSR Gosplan. Tailings under consideration include debris and fallen rocks, enrichment tailings, slags and slurries, phosphogypsum, ashes, slag from thermal electric power plants and boiler rooms, carbonaceous tailings, pyrite cinder, scorched sand from casting molds, waste paper as well as textile and rubber waste. Collection and utilization of these tailings are already being improved by implementation of a system and norms, by classification and rating

of secondary raw material in the tailings as well as a determination of the level of their use, and by coordinated planning of all scientific research activity in this area. The still inadequate utilization of secondary non-ferrous-metals resources by various industries and enterprises is attributed to lack of specialized equipment and transportation facilities. The industries particularly affected are those producing copper, titanium, magnesium, and zinc, but production of structural materials is also affected to some extent. An interesting report was given on the needs of agriculture for fertilizers based on nonferrous metals. The seminar covered also economic problems of tailings collection and utilization, namely capital investment and cost effectiveness. Further goals are extensive research on replacement of primary raw material with secondary sources and development of a low-waste or wasteless technology to be introduced into the nonferrous metals industry at an accelerated pace.

[34-2415/12955]

UDC 669.187.56

#### IMPROVING QUALITY OF HIGH-TONNAGE SHEET INGOTS PRODUCED BY ELECTROSLAG SMELTING

Moscow STAL' in Russian No 9, Sep 85 pp 34-36

KAPUSTIN, I. V., CHAPNI, B. B., QGURTSOV, Yu. L., AKULOV, V. P. and POPOV, S. S.

[Abstract] Electroslag smelting (ESS) using flux with minimal oxidizing capability is used to produce highly homogeneous ingots. The present article reports on ESS of 09G2S and 16G2AF converter steels, as well as other related steels. Data on the chemical homogeneity of the ingots are of use for determining metal quality and technical section, the effectiveness of the flux's refining action and geometrical dimensions of the ingots. Data on changes in content of silicon, manganese and aluminum in 16G2AFSh steel are presented. Manganese content was found to be dependent on the amount of ferrous oxide in the steel, with stable minimum values of Mn oxidation at 500-700mm from the bottom plate. The sulfur balance during various stages of smelting showed that its transition from the slag to the gaseous phase was more intensive during feed than during actual smelting. Oxidation (rather than reduction) of silicon was related to the increase in iron oxide concentrations and their activity as temperature increased from 1380-1520°C and 1650-1670°C in various tests. 16G2AF steel showed greater desulfuration than 09G2S. Other factors of manganese oxidation and sulfur absorption are summarized. References 3: all Russian.

[39-12131/12955]

## EFFECT OF HYDROSTATIC GAS PRESSURE ON STRUCTURE AND PROPERTIES OF AL9M ALLOY CASTINGS

Moscow LITEYNOYE PROIZVODSTVO in Russian No 9, Sep 85 pp 11-12

VERSHININ, P. I., candidate of technical sciences, BELOUSOV, N. N., doctor of technical sciences, MASHKOVITSEV, V. P., and SEBASTYANOV, V. I, engineer's

[Abstract] In an experimental study the AL9M alloy was cast under hydrostatic gas pressure up to 15 MPa high, in a semiindustrial autoclave which had been designed for minimization of the free volume. The effect of hydrostatic gas pressure on the thermal kinetics was evaluated during casting of 1.4 cm thick 8x10 cm<sup>2</sup> plates, with the initial mold temperature  $T_m = 20^\circ\text{C}$  and the gage pressure raised from zero successively to 7, 11, 15 MPa. The rate of heat flow from casting to mold, determined on the basis of thermocouple readings, was found to decrease first as the clearance between casting and mold widened and then to increase with higher pressure owing to the longer time of effective contact between casting and mold, also because of increasing density and improving thermal properties of compressed gas. It was found to decrease again with higher pressure toward the end of the process, because of the lower heat content in the casting. This trend, followed also by the corresponding heat transfer coefficient, indicates that raising the pressure increases the intensity of heat transfer. The dependence of the casting structure and the alloy properties on the process mode, namely the pressure-temperature-time relation, was evaluated on cylindrical specimens 50 mm high and 90 mm in diameter, in steel chills. The results, revealing a close correlation between structural changes and mechanical properties, indicate the optimum process conditions. These are the lowest practicable initial mold temperature and a compression time longer than the solidification time, with constant pressure maintained during solidification and with the shortest possible time lapse between melt injection and application of pressure. Engineer A. K. Timokhin in the study participated.

References 1: Russian  
[41-2415/12955]

## DEPENDENCE OF SILUMIN CASTING QUALITY ON DEGREE OF MELT MICRO-HETEROGENEITY

Moscow LITEYNOYE PROIZVODSTVO in Russian No 9, Sep 85 pp 12-13

KAPUSTNIKOV, S. V., candidate of technical sciences, MAZUR, V. M., doctor of technical sciences, and TARAN, Yu. N., doctor of technical sciences

[Abstract] Casting of two silumin alloys, binary Al+ 12% Si and ternary Al+ 12% Si+ 0.6% Fe, is evaluated for the purpose of determining how the cooperative buildup of their eutectic phases and thus the quality of castings

depend on the degree of melt microheterogeneity. A quantitative relation between concentrations of the phases, including the  $\text{Fe}_2\text{Al}_5$  phase in the ternary alloy, and parameters of the short-range order is established on the basis of the "liquid phase" model with the initial Si concentration not depending on the temperature so that the temperature dependence of the melt composition is determined by Al and Fe only. The degree of microheterogeneity, determined by Al and Fe only. The degree of microheterogeneity, determined entirely by the number of type and the stoichiometry of structural zones including the zone of heterophase atom complexes, in turn determines the degree of alloy casting eutecticity. The theory has been confirmed by experimental data on the ternary alloy superheated to  $850^\circ\text{C}$  and held for 5 min at that temperature, stirred and then poured into two thin-walled crucibles, from one of which it was quenched in water directly and from the other one only after precooling to and holding at  $600^\circ\text{C}$ . References 1: Russian [41-2415/12955]

UDC 621.74:669.154.9

#### USE OF REMELTED SILUMIN CHIPS FOR CASTING PISTONS

Moscow LITEYNOYE PROIZVODSTVO in Russian No 9, Sep 85 pp 13-14

AVDENTOV, L. S., candidate of technical sciences, and POTANIN, S. L., candidate of technical sciences

[Abstract] Hypereutectic silumin for diesel pistons contains scarce and expensive alloying copper, nickel, molybdenum so that recycling of the chips produced in the machining process becomes economically expedient. Chips must be degreased, in a special drum at  $750\text{--}800^\circ\text{C}$ , with safety measures preventing ignition or explosion of the volatile combustible kerosene used as lubricant-coolant in the machining process. Dry chips are remelted in an induction furnace and then refined in a fluid bath with  $\text{KCl}$  or  $\text{KCl} + 2\text{--}12\% \text{K, Na carbonates or nitrates}$ . Molten chip metal with this flux is superheated to  $800\text{--}1000^\circ\text{C}$  with continuous stirring, accompanied by first sporadic and then intense emanation of a white smoke as well as by deposition of an easily removable dry slag on the vat surface. The flux ( $\text{KCl}$ ) mixes with  $\text{Al}_2\text{O}_3$  particles, after having wetted them, and reacts with them as well as with other oxides exothermically so that it heats up to a temperature above the metal temperature and subsequently evaporates. This evaporation is beneficial, inasmuch as it removes nonmetallic inclusions from the melt. The chip melt at  $1000\text{--}1050^\circ\text{C}$  is poured into ladles together with the primary alloy melt at  $800\text{--}900^\circ\text{C}$ , whereupon both are thoroughly mixed. The mixture is poured into crucibles for treatment with a cake of  $30\text{--}40\%$  hexachloroethane +  $7\text{--}17\%$  sulfur powder +  $48\text{--}58\%$  nickel granules and scavenging with nitrogen, whereupon it is ready to be poured into chills immediately. Castings with the best mechanical properties, 10% higher than nominal strength, maximum comminution and most uniform distribution of silicon are produced by mixing chip melt at  $1025^\circ\text{C}$  with primary alloy melt at  $850^\circ\text{C}$ . Implementation of this technology can save over 2,000 tons of silumin and over 300,000 rubles annually, with a correspondingly reduced consumption of copper, nickel and silicon. [41-2415/12955]

## CONTINUOUS CASTING OF THIN-WALLED GRAY-IRON INGOTS

Moscow LITEYNOYE PROIZVODSTVA in Russian No 9, Sep 85 pp 17-18

SDOBNIKOV, V. L., engineer, PUSTOVALOV, Ye. V., engineer, VEREVKIN, V. M., engineer, and GAYDUK, A. V., engineer

[Abstract]-- The horizontal continuous-casting process has been adapted for producing thin-walled gray-iron angle ingots, on the basis of a development study made at the Tashtekstil'mash (Tashkent Textile Machinery) plant imeni Yu. A. Gagarin with assistance from the Lipetsk branch of the All-Union Design and Technological Institute of the Casting Industry. Experimental casting of 18 mm thick 94x98 angles was done on the LNLCh-3 line, into a shaped crystallizer consisting of graphite inserts and a metal cooling casing Pig iron containing 3.5-3.7% C, 2.4-2.7% Si, 0.3-0.4% Mn, 0.1-0.15% P and 0.06-0.08% S was melted in the cupola at 1640-1670 K temperature. The casting rate was varied over the 0.003-0.006 m/s range, with the temperature of ingots leaving the crystallizer varying over the 1200-1320 K range. Ingots with the best characteristics were produced by intensification of surface cooling from below so as to reduce the distances between the solidification front, at the corner and the two tips of the angle section, and the bottom line of the cooler below to less than 0.004 m, 0.015 m, 0.005 m respectively. This allowed the casting rate to be raised to 0.006 m/s. Subsequent structural examination revealed that proneness to cracking would increase with the two angle arms equally inclined so that the solidification front would originate all in the same crystallizer cross-section. An offset is therefore preferable, inasmuch as it will inhibit formation of gas locks. Stability of the casting process and quality of the product are, accordingly, determined by configuration of the solidification front as well as by lengths of both the hot zone and the transition zone in the crystallizer. Straightening the solidification front and shortening the transition zone will contribute to higher stability and better quality. Engineer Ye. P. Demchenko and engineer Kh. M. Mirsamatov participated in the study.

[41-2415/12955]

UDC 621.745.4.002.73:621.365.5

## DECONTAMINATION OF SCRAP IRON FOR SMELTING INDUCTION FURNACES

Moscow LITEYNOYE PROIZVODSTVO in Russian No 9, Sep 85 pp 26-27

KONYUKH, V. Ya., candidate of technical sciences, ASANIN, V. P., engineer, SERYY, V. P., engineer, and YURCHENKO, G. D., candidate of technical sciences

[Abstract] Since electric induction furnaces operating at industrial frequency are now more extensively used for melting pig iron and the energy requirement, on the order of 700 kW·h at approximately 60% thermal efficiency

for 1 ton of pig iron, depends on the quality of the charge, it becomes economically expedient to decontaminate the scrap. This process involves removal of moisture, barren rock, iron oxides, and organic lubricants. The process includes preheating above the boiling point of water and afterburning at 900°C in an oxidizing atmosphere. Apparatus for this purpose, using natural gas as fuel, has been developed at the Institute of Natural Gas (UkSSR Academy of Sciences). It has been designed in three versions. The turret configuration with heating in a single stage followed by burning requires respectively 16.5 m and 20 m of natural gas per ton of scrap. The feed-through configuration with heating in two stages and intermediate burning requires a total 27.2 m of natural gas per ton of scrap. Both versions can be built in four sizes for processing respectively 2, 3.6, 6, and 14 tons/h. A variant of the second version includes recirculation of the flue gas for heating, which reduces the fuel requirement to 20 m per ton of scrap. All versions are equipped not only with burner control and regulation but also protective automation for monitoring the flames and shut-down when the gas pressure changes or the temperature of combustion products rises above the safe limit. Implementation of the scrap decontamination technology with this apparatus should increase the productivity of induction furnaces by 20-23% and save 100-130 kW·h of energy per ton of scrap. References 2: both Russian [41-2415/12955]

## TREATMENTS

### NEW BLOOMING MILL INSTALLED IN CHELYABINSK PLANT

Moscow SOTSIALISTICHESKAYA INDUSTRIYA in Russian 24 Jul 85 p 1

[Article by N. Krivomazov, SOTSIALISTICHESKAYA INDUSTRIYA correspondent]

[Text] Two precisely directed explosions rumbled above the city at night. They removed from the old foundations the most recent equipment of the third 1300 blooming mill at the Chelyabinsk Metallurgical Combine. By such an unusual salute the city bade farewell to a rolling mill veteran which operated for many years and which must make way for a new mill manufactured at Uralmash.

But an hour earlier the blooming mill was still operating. At 21:45, operators Grigoriy Semenyuta and Viktor Lomanov rolled the last two ingots on it and then shut it down. It seemed that all of the combine came to bid farewell to the unit that was still hot from exertion. But literally within a minute the riggers began the dismantling. They were committed to remove 2,500 tons of metal, 1,000 tons of reinforced concrete, and almost as much earth in 24 hours.

An explosion resounded, and the night shift began the first shift of the thirty shifts leading to the record.

--The Chelyabinkites have committed themselves to put a new mill within the old walls in ten days,--said Combine Director A. Litovchenko.--The Southern Urals have never seen such time limits. Nevertheless, every hour of the accelerated reconstruction has been calculated and supported by a network schedule for the overhaul. According to the schedule, the underground speedsters of German Vorvanin from the Shakhtoprokhodka trust have already prepared the new foundations.

Up to 1,000 people per shift are working on the accelerated reconstruction. The startup of the 1300 blooming mill ahead of schedule will permit the production of an additional 75,000 tons of rolled metal beyond the plan. The first day of the reconstruction is going strictly according to schedule. The first "urgent telegrams" report: Nine days remain to the startup of the mill.

12863/12955  
CSO: 1842/26



## A NEW THEORY OF ROLLING

Moscow SOTSIALISTICHESKAYA INDUSTRIYA in Russian 4 Sep 85 p 2

[Article by Academician A. Belov]

[Text] Rolling processes with large reductions have undergone significant development and broad application in the production of various types of metal products.

However, the theory of these processes has been poorly developed up to the present. Many questions remained either unanswered or insufficiently substantiated. This has to a large extent restricted both the improvement and the accelerated development of rolling with large reductions. The monographs of Professor and Doctor of Technical Sciences P. Teterin, "The Theory of Cross and Helical Rolling" and "The Theory of Periodic Rolling", which have been admitted to the USSR State Prize competition, fill in the gaps. They were written on the basis of original studies of the author. Each is an independent, fundamental work, and nothing similar exists either in our or the world's technical literature. Problems having especially important scientific and practical significance are formulated and solved in them on the basis of profound and comprehensive analysis. The results of the studies and the various calculation methods are used widely by planning and design and scientific research institutes, and machine-building and pipe rolling plants, as well as by universities in the educational process. The great contribution of P. Teterin to the creation and development of the theory of rolling is widely known both here and abroad, and his monographs serve as reference books for specialists. The many ideas, propositions, and conclusions presented in the monographs have become the basis for the development and fundamental improvement of processes.

Under the existing method of broaching billets in two-roll helical rolling mills, fissures and blisters often form on the inner surface of the shells, which lead to spoilage and are the cause of the considerable limitations of the assortment of seamless pipe by quality of steel. On the basis of his analysis of the causes of these effects, P. Teterin proposed the use of a three-roll mill instead of the two-roll mill. One such unit alone yielded a savings of more than 15 million rubles.

Anyone who has previously been in a pipe-rolling plant certainly paid attention to the unbelievable roar of the rolling equipment. This, with enormous force literally "hammers" the billet between the rolls of the mill; the billet resists and often ends up as a reject. The increased metal consumption, the decrease in mill productivity, and the impossibility of process automation -- that is far from a complete list of the shortcomings of this equipment. P. Teterin showed that a completely even and absolutely sure grip was possible in helical rolling mills. To do this it is enough to impart to the billet a forward rotary motion, and not just a forward motion, as previously. Today that fundamentally new method is widely used.

The monograph of P. Teterin contribute to the acceleration of scientific and technical progress and merit conferment of the USSR State Prize.

12863/12955

CSO: 1842/26

## INCREASING WEAR RESISTANCE OF COLD PIPE ROLLING MILL MANDREL RODS BY ULTRASONIC DIAMOND SMOOTHING

Dnepropetrovsk METALLURGICHESKAYA I GORNORUDNAYA PROMYSHLENNOST in Russian  
No 3, Jul-Sep 85 pp 27-28

BALAKIN, V. F., BONDARENKO, V. M. and LITVAK, V. P., Dnepropetrovsk Metallurgical Institute

[Abstract] Results are presented from experimental and production studies intended to select effective conditions for diamond smoothing of mandrel rods for cold pipe rolling mills. The rods were made of type 60S2KhFA steel, HRC54-58. The static pressure and the amplitude of the oscillations of the smoother were found to influence surface microhardness. The maximum surface microhardness of 8000-8200 MPa with minimum static force of 60-70 N was achieved with an oscillation amplitude of 15  $\mu$ m, which rapidly cracked the diamond tip. Therefore, the optimal values of these parameters were found to be 10  $\mu$ m, static force 90 N. Surface microhardness was increased by 20-25%, from 5800-6400 to 8000-8200 MPa, under these conditions. The process also significantly reduced surface roughness of the mandrel rods. The process can therefore replace polishing. It increases the life of mandrel rods by 50%. References 2: both Russian.  
[42-6508/12955]

UDC 621.774.35:669.141.24]:65.015.13

## PRODUCTION OF PETROLEUM INDUSTRY PIPE FOR USE UNDER LOW TEMPERATURE CONDITIONS

Dnepropetrovsk METALLURGICHESKAYA I GORNORUDNAYA PROMYSHLENNOST in Russian  
No 3, Jul-Sep 85 pp 34-35

NEFEDOV, Yu. A., BYCHKOV, Yu. V., SOBOLEVA, T. V., RYNKEVICH, Yu. Yu., KRAVTSOV, M. V. and KABAKOVA, N. V., Dnepropetrovsk Metallurgical Institute, All-Union Scientific Research and Design-Technological Institute of the Pipe Industry and Nikopol Southern Pipe Plant

[Abstract] The authors' organizations, in cooperation with the Azerbaijan Pipe Rolling Plant, have mastered the production of pump-compressor pipe and sleeves of strength group D, with increased ductility and cold resistance, made of steel containing 0.42-0.48% C, 0.75-1.0% Mn, 0.20-0.35% Si, not over 0.015% S, not over 0.040% P, 0.01-0.03% Al. The metal is deoxidized in the ladle. Silicon and manganese-containing ferroalloys are introduced under the jet of metal when the ladle is one fourth full. The steel is refined outside the furnace with a liquid lime-alumina slag, poured by a siphon method and rolled. Sulfide content is not over grade 2.5-3.0, silicate and oxide content not over grade 3.0-3.5. Reference 1: Russian.  
[42-6508/12955]

## STRAIGHTENING OF PRECISION PIPE WITH POLYURETHANE TOOL

Dnepropetrovsk METALLURGICHESKAYA I GORNORUDNAYA PROMYSHLENNOST in Russian  
No 3, Jul-Sep 85 pp 35-38

SITNIKOV, L. L., STERIN, Yu. M., DEMAPOV, M. V., CHIDAKINA, G. P.,  
SAMOYLENKO, G. D. and LISOVSKIY, A. A., Urals Scientific Research Institute  
of the Pipe Industry and Nikopol Southern Pipe Plant

[Abstract] The authors' organizations have developed and introduced a new technology for the straightening of smooth and finned pipe made of special alloys on straightening machines using polyurethane straightening tools. The new technological process has been implemented on existing 6-roll pipe straightening machines and a 7-roll machine. Straightening with the elastic tool has a number of peculiarities resulting from the physical and mechanical properties of polyurethane. Its low rigidity helps to increase the contact surface, favorably influencing the quality of the straightening but increasing the rotation resistance of the rolls. Another peculiarity is cyclical deformation of the contact layer of the elastomer, accompanied by intensive heat liberation, which requires good heat transfer away from the contact zone to avoid damage to the plastic. References 3: all Russian. [42-6508/12955]

UDC 621.984.5(0:01)

## IMPROVED PRESSING OF COPPER ALLOYS

Moscow TSVETNYYE METALLY in Russian No 9, Sep 85 pp 63-66

KASATKIN, N. I. and YERMANOK, M. Z.

[Abstract] Contributions made by Yu. F. Shevakin to the art of pressing copper alloys are reviewed on the occasion of his sixtieth birthday. His contributions include scientific research and practical inventions pertaining to most processes which involve plastic deformation, but only his improvements of the tube manufacturing and profile shaping technologies are considered here. He is the author or coauthor of 3 monographs and over 70 articles dealing with stress and strain analysis, friction and lubrication, design of tools and feed mechanisms for maximum wear resistance, and related subjects. One outstanding contribution of his is development of methods for evaluation and optimization of the technological processes under laboratory as well as industrial conditions, on the basis of loading and deformation analysis. Another outstanding contribution, made by him jointly with A. M. Rytikov, is development of a mathematical model for analysis and optimization of the production economy, covering the entire complex with the electric power supply included as well as force-time and temperature-speed characteristics. Press forming and heat treatment procedures have been designed on the basis of this model which make it possible to produce tubes of durable material with high precision at low cost. References 25: all Russian. [34-2415/12955]

## DEVELOPMENT OF THEORY AND TECHNOLOGY OF TUBE ROLLING WITH VARIABLE-RADIUS ROLLERS

Moscow TSVETNYYE METALLY in Russian No 9, Sep 85 pp 66-70

MATVEYEV, B. N.

[Abstract] Cold rolling of tubes by the periodic process in Pilger mills with reciprocating motion of the ribs is analyzed theoretically on the basis of the simple Teterin-Rogov relation and the more precise Tselikov and Osada relations. Calculations based on a system of integral equations are found to be more accurate than calculations by the MIS (Moscow Institute of Steel) method based on the differential equation describing the change of cross-sectional area along the gauge cone. On the basis of this theory multithread rolling mills such as the Aetna Standard (USA) triple-thread mill have been designed and built. The productivity of such rolling mills is further increased by sequential-simultaneous deformation of the gauge cone with two pairs of rollers, one behind the other, and continuous-periodic feed of the metal. Although the theory of this process has not yet been finalized, excellent experience is reported by plants where such a tandem rolling mill are operating (All-Union Scientific Research and Engineering-Manufacturing Institute of Steel Industry, Southern Tube Manufacturing Plant, "Elektrostal" Heavy Machinery Manufacturing Plant). Extended use of cold rolling with a forward feed stroke only is recommended for thin tubes made of low-plasticity alloys. References 40: all Russian.  
[34-2415/12955]

UDC 621.778.01

## MULTIPASS DRAWING OF ALUMINUM WIRE WITH ROLLERS

Moscow TSVETNYYE METALLY in Russian No 9, Sep 85 pp 78-80

SHLIOMENZON, B. Kh., KOZLOV, V. G. and SPIRIN, V. Ya.

[Abstract] A technology of drawing aluminum wire has been developed, a multipass process with alternate feeding through a monolithic drawplate and between rollers. The process parameters were determined on the basis of a first-order 2-factorial experiment and regression analysis of the results, with the ratio of elongation in rollers to total elongation and the drawing speed as principal factors influencing the mechanical strength of the produced wire. Constant cooling was assumed so as to make the temperature rise depend on the drawing speed only. The routing has been designed for mills with stationary kinematic extruders, which do not allow the advantage of rollers to be fully realized. The process has been designed to produce maximally strong circular wire without elliptic distortion of the cross-section, and for a smooth changeover from conventional drawing with VN or

or VMA monolithic drawplates only. Wire samples produced by both methods were actually tested for tensile strength, 95% of all samples produced by the new method having had a strength of at least 157.1 MPa and those produced by the conventional method a strength of at least 148.5 MPa only.

References 7: all Russian.

[34-2415/12955]

UDC 621.865.8

#### INTRODUCTION OF ROBOTS AT MAGNITOGORSK CALIBRATION PLANT

Moscow STAL' in Russian No 9, Sep 85 pp 60-62

STOBBE, L. G. and DEREBAS, A. I., Magnitogorsk Calibration Plant

[Abstract] The article reviews implementation of automation at the Magnitogorsk Calibration Plant. Guided by the Central Laboratory for Automation and Mechanization, the plant first introduced automated lifting and transport manipulators for feeding bell furnaces. That robotic device is diagrammed and its operation explained. Certain shortcomings in this initial design revealed during use, such as poor centering for feed rolls of varying diameter, were corrected in a subsequent modification. A robot technical complex (RTC) based on crank presses for stamping and shaping transporter chain links were also built, freeing one worker and partially freeing another from tedious labor, although manual removal of the stamped product was still required. In 1983 a new mechanized system was put into test operation for packing spools with metal cord in boxes. Two shelf-packing automatic systems have also been put into use, and nine new automated systems are to be put into use in the current year. Since the plant has a relatively high level of automation already, the potential for additional robot applications is limited. The authors stress that automation should be included in plants at the planning stage.

[39-12131/12955]

UDC 669.018.4:061.3/4:621.382.002

#### POWDER-METALLURGICAL DEVELOPMENT OF MATERIALS BASED ON REFRACTORY COMPOUNDS FOR ELECTRONICS APPLICATIONS

Kiev POROSHKOVAYA METALLURGIYA in Russian No 9, Sep 85 (manuscript received 3 Dec 84) pp 34-39

KOSOLAPOVA, T. Ya., DVORINA, L. A. and SASOV, A. M., Institute of Materials Science Problems, UkSSR Academy of Sciences

[Abstract] A survey was made of the bulk and film electrical properties of disilicides of Ba, Ti, Ta, Cr, Mo, W, Mn, Re, Fe, Co and Ni. The advantages

of using complex silicide solid-solution systems containing  $\text{CrSi}_2$  for micro-circuit resistors are: a wide range of physical properties and material properties not critical over wide concentration range. The latter advantage ensures reproducibility using sputtering technology. Study made of electrical properties of  $\text{CrSi}_2\text{-TiSi}_2$  and  $\text{CrSi}_2\text{-TaSi}_2$  solid solutions showed that change in majority carrier concentration can vary resistance, temperature dependence of resistance and temperature coefficient of resistance. These solid solutions have greater oxidation resistance in air up to  $1200^\circ\text{C}$  than individual silicides. Concentration ranges were determined in which properties are not sensitive to changes in composition. Vacuum powder metallurgy was used to produce powders and films of necessary purity and films with proper component distribution. References 18: 16 Russian, 2 Western.  
[46-12595/12955]

UDC 669.15'26'295:620.17

#### DEPENDENCE OF MECHANICAL PROPERTIES OF OKh18T1 CORROSION-RESISTANT SHEET STEEL ON PERCENTAGE OF COLD DEFORMATION

Moscow IZVESTIYA AKADEMII NAUK SSSR: METALLY in Russian No 5, Sep-Oct 85  
(manuscript received 13 Apr 84) pp 94-97

SHESTAKOV, I. A. and SNEZHKO, N. V., Zaporozhye

[Abstract] The standard technology of producing Okh18T1 corrosion-resistant sheet steel is initial hot rolling to 3.8 mm thickness followed, without intermediate heat treatment but after basic-acidic pickling, by final cold rolling to 0.8-2.0 mm thickness. These strips are heated to  $960\text{-}970^\circ\text{C}$  in a continuous furnace and held there for 1.5 min/mm thickness, then again pickled before being cut into sheets. Data on the mechanical properties of this product (yield strength, tensile strength, percentage elongation), based on 700 lots of samples and 1435 readings, were processed on a computer according to a special program. The results indicate that the mechanical properties of this material depend more on the percentage cold reduction than on the final thickness of the strip. The dependence of the percentage elongation and thus of the plasticity on the percentage cold reduction is an extremal one, with maximum plasticity attained upon 55-65% cold reduction. Both yield strength and tensile strength are almost independent of the percentage cold reduction. References 11: all Russian.  
[45-2415/12955]

## LASER CONTROL OF KINETICS OF HETEROGENIC OXIDATION OF METALS

Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 284, No 4, Oct 85  
(manuscript received 17 Dec 84) pp 838-840

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[Abstract] The process of oxidizing metals with formation of a dense scale on the surface involves concentration and temperature gradients in the oxide film and the charge state of the diffusing particles. The present article gives the results of theoretical and experimental study of the effects of photoionization of inherent defects in the crystalline structure responsible for the mass transfer of reactive components through the oxide film on the rate of metal oxidation. Theoretical studies show that the results of the photoionization of defects on the oxidation rate depend on the nature of the oxide, the oxide coating thickness, and the magnitude and direction of the temperature gradient. The theoretical conclusions were verified experimentally with polished copper and cobalt specimens. In the first group experiments the metal targets were heated by the continuous laser irradiation. Changes in target weight during oxidation were measured. The results indicated that photoionization reduced the rate of oxidation. In a second group of experiments, copper targets were oxidized in an electric oven at 1250 K, then subjected to laser irradiation. This laser irradiation resulted in more weight gain due to oxidation than that found without the illumination. Thus, various types of laser irradiation was judged to be effective for controlling the kinetics of heterogenic metal oxidation. References 6: all Russian.  
[52-12131/12955]



## EXTRACTIVE METALLURGY AND MINING

### COMPLEX ORE EXTRACTION PROCESS A FIASCO

Moscow SOTSIALISTICHESKAYA INDUSTRIYA in Russian 10 Sep 85 p 2

[Article by A. Valentinov SOTSIALISTICHESKAYA INDUSTRIYA correspondent]

[Text] Having returned from a trip and sat down at the desk, I suddenly discovered a paradoxical fact: there are no guilty parties in this story. And there is no one to make responsible. It is not my intention to punish anyone for old mistakes--the statute of limitations, as they say, has run out. But should, in fact, somebody assume the responsibility for a faultless resolution of a complicated tangle of problems? Such are not found. All have a collective responsibility, so to speak. In other words, it's a draw.

But in fact this story begins precisely with responsibility--for the country's natural riches and for their rational utilization. It began long ago, as far back as the thirties, when the unique Nikolayevskoye deposit was discovered in East Kazakhstan. Iron, copper, lead, sulfur, and rare metals--nature has not been stingy. But there were no methods in the world to process the ores in the complex without losses of some metals. At that time the decision was made to preserve the richest treasures until such methods emerged. Even in the most difficult war and post-war years when there was an urgent need for nonferrous metals, these riches were kept back and saved.

Such methods appeared after thirty years. One of these came into existence within the walls of the VNIItsvetmet [All-Union Scientific Research Mining-Metallurgical Institute for Nonferrous Metals]--it combined several technological processes in one unit. It was given the name: oxygen-suspended cyclone electrothermal smelting, abbreviated as kivitset [kisllorodno-vzveshenno-tsiklonnaya-electrotermicheskayaplavka]. In addition to complete extraction of the metals, the new method promised to mechanize and automate the production, to improve working conditions, and to safeguard the environment. A small-scale experimental model of the unit, constructed at the institute, confirmed the practicality of these expectations. Then, on the basis of the recommendations of USSR Mintsvetmet [Ministry of Nonferrous Metallurgy], the prohibition with respect to the Nikolayevskoye deposit was lifted. And at the Irtyshsk Copper Smelting Plant a large experimental-industrial unit for processing copper-zinc ores was built on the basis of a Kazgiprotsvetmet design at which the technology for future kivitset units would be developed.

Fifteen years went by. And here we, with A. Loskutov, chief engineer of the Kazgiprotsvetmet project, are passing the entrance of Irtyshsk copper smelting plant. Chief Engineer of the plant V. Ponomarev, looking at our clothes and skeptically shrugging his shoulders, led us to the shop where the new unit is operating. His scepticism became understandable when we, choking and coughing, slipped out of the shop into relatively fresh air. I never saw a "smokier" production unit, to say nothing about safeguarding the environment. Also, there wasn't even a trace of automation or mechanization. And this was the unique unit for which we had waited for fifty years?

--If it is unique, then it's only for the damage it's causing--briefly summarized the chief engineer of the plant.

Some of the damage is very clear. A huge slag pile is accumulating in the plant yard, and the cost is millions. Here are zinc and other metals which kivitset cannot recover, only one, copper, being extracted from the Nikolayevskoye ore. To give the "wastes" to road builders is a crime, and they do not know how to use it.

Where is the real kivitset?--I asked.--That about which so much was written and movies made?...

--This is it. There are no others.

So, the unit on which they placed so many hopes is functioning as an ordinary copper-smelting furnace, only with indicators that are half as good. But, you see, industry plans indicated the construction of large kivitset units--at the Eastern Kazakhstan Copper-Chemical Combine, especially for Nikolayevskoye ores, and here, at the Irtyshsk copper smelting plant.

--And it's good that, they not build them--smiled A. Loskutov.--It would have been the same as here. From the very beginning we indicated that the process was not worked out, that the experimental base was insufficient. They compelled us to plan a design deliberately doomed to failure. They were very much in a hurry.

They were in a hurry! That's the key to this failure. The idea captured the imagination, and the initial successful experiments did not leave a place for comparative analysis. And it was needed. Any new technology must withstand rigorous competition with other possible ones for a given production unit. This helps to identify the "sore points" of the new development and to bring it to perfection. None of this was done.

--We didn't have any choice--explained Kazgiprotsvetmet director A. Lustin. Even at the time there already were some technologies for complex ores, but VNIItsvetmet did not develop any of these except its own. And the decision about developing the Nikolayevskoye ore deposit, where they invested 140 million rubles in the construction of the mine and the concentrating mill, forced the ministry to hurry us with the project.

The designers and researchers, Kazgiprotsvetmet and VNIItsvetmet, are both located in Ust-Kamenogorsk. They cannot exist one without the other--the scientific results of the researchers are converted by the designers into specific machines and technologies. But they do not get along: all these fifteen years there has been no agreement between them. The designers did not have enough data, and that which they were given caused doubts on their part. In response the researchers charged them with groundless criticism. This is the level the controversy was conducted on. Of course, not in Ust-Kamenogorsk--but in Moscow; the all-union Mintsvetmet stood behind the researchers.

Some of the "arguments" in this debate were completely unscientific. Thus, the designers from the very start argued that the experimental-industrial unit of the Irtyshsk plant could not operate as intended. In reply, it was given the status of industrial by order of the ministry, that is, that it was completely developed. And they determined the plan indicators for it "from the attained"--which were only half the design values. And this automatically blocked the way for further research: when they lowered the plan for the unit--what kind of science is that!

The question arises: what to do next, how to cut through the tight knot of problems? We spoke to the First Secretary of East Kazakhstan Party Obkom A. Milkin about this.

--I think, in the end, that the designers were right--said Anatoliy Vasilevich. And the way out which they had suggested, for me, is indisputable: start all over again. To carry out a complete group of studies applicable to the local ores, and not only by the kivitset method. There are, in fact, other technologies. In particular, a process created in our country, liquid bath smelting (LBS), is very promising.

--Smelting in a liquid bath has only been studied slightly so far--objects VNIItsvetmet director A. Sychev--And kivitset needs only to be brought to standard. We are now constructing a new unit for processing lead-zinc ore at the Ust-Kamenogorsk Lead-Zinc Combine. And although the designers assert that it also lacks an experimental base, I am confident that it will work extremely well. They are also confident at the ministry.

They are really confident at the ministry. This was confirmed for me by Deputy Minister V. Boroday. He resolutely took the side of the researchers.

--It's too late to change anything. At one time they committed a major error: they became so engrossed in kivitset that they did not provide for the creation of units for verifying other technologies. To build them now means to lose 5-6 years. Therefore, the Ministry collegium as far back as 1982 selected kivitset from among the three variants proposed by Kazgiprotsvetmet for processing Nikolayevskoye ore, even though the institute itself recommended liquid bath smelting. They reasoned thus; kivitset could be brought along faster. Although it produces only copper and not zinc and other metals, it does this well.

--But what kind of sense is it to convert a promising unit into a common copper-smelting furnace, even if it is a good one? Especially as we have waited and struggled for so many years in order to completely and fully utilize the riches of the Nikolaevskoye ore.

--There are no ores greater the deputy minister sighed--In fact, all those years, while we looked forward to kivitset, the mine produced and the plant benefited. It was necessary to put the output somewhere. We hauled the overflows to various plants. And everywhere with great losses: either the metal was wasted or the economics went to hell. And now what's left--he waved his hand--it will be kivitset.

Three years have passed since this collegial decision, and there is no one personally answerable for its correctness and its economic feasibility... But even now the Deputy Minister refers to it, as if since then there had not been either the April Plenum or the June meeting of the CPSU Central Committee, which set forth the task of accelerating the social and economic development of the country on the basis of scientific and technical progress and which demanded a drastic change in minds and attitudes. And it does not disturb my interlocutor that the design of a new kivitset complex for processing complex ores from different deposits has not been confirmed by Gosstroy [State Construction Committee] and Gosplan [State Planning Committee] for a variety of reasons, among which is the non-development of the technology.

12863/12955

CSO: 1842/26

## TASKS FOR GEOLOGISTS OUTLINED

Moscow PRAVDA in Russian 28 Sep 85 p 1

[Unsigned editorial]

[Text] The mineral resources of our country indeed hold great treasures of nature. But their reserves are not infinite. That is why it is so important today to have a precisely adjusted strategy for geological exploration and prospecting operations to find new raw material reserves. The strengthening of the raw material base of the national economy of the country is dependent in many respects on the reliability of forecasting and the intensity of the search.

The leading collectives of the USSR Ministry of Geology are working successfully on fulfilling the intensive goals of the final year of the 5-year plan. The 5-year plan goal for an increase in the proven reserves of gas, lead, zinc, and bauxite was fulfilled ahead of schedule. There are a number of new discoveries to the account of the geologists. The prospecting of the Karachaganakskoye oil-gas-condensate deposit in the Caspian Sea area and the Kholodninskoye lead-zinc deposit in the BAM [Baikal-Amur Mainline] area was completed. New oil and gas reserves were found. The Obneftegazgeologiya association was the first in the industry to fulfill the 5-year plan for increasing the oil reserves. Production leaders are setting an example in labor. More than a thousand drilling and mine-digging brigades fulfilled the 5-year plan goals ahead of schedule.

However, not all of the collectives of the sector met the goals. Thus, the 5-year plan for increasing oil reserves was not fulfilled by the Tomskneftegazgeologiya, Vostsibneftegazgeologiya, and Yensieyeftegazgeologiya associations.

The omissions in the operation of a number of sector subdivisions are explained by the poor utilization of the achievements of scientific and technical progress. Some geological associations of the Russian Federation, Kazakhstan, and the Turkmen SSR did not fulfill the goals for the volume of deep drilling. Sometimes the geologists make poor use of productive capital and do not ensure order and discipline in the collectives where large amounts of working time are lost.

In accordance with the decisions of the April (1985) Plenum of the USSR Central Committee, a swing toward the intensification of prospecting and exploration operations based on scientific-technical progress has been planned in the associations and geological expeditions. It is necessary for party committees and managers to even more actively generate in all toilers of the sector a sense of personal responsibility for the realization of the tasks facing geologists and for the unconditional fulfillment of the plan for the final year of the 5-year plan. For the mineral explorers this is difficult, but achievable. It is necessary for geologists to greatly increase the efficiency of their operations, and, first of all, to raise its scientific potential. The point above all is that of more reliable recommendations in choice of the directions and scale of the search.

Today the industry has a good scientific and technical arsenal available. Nevertheless, and this was mentioned at the meeting of the party-economic aktiv at Tyumen, the accuracy and reliability of scientific forecasting of prospecting and exploration operations are such as to cause serious concern. It is necessary to strengthen the scientific research that affects the development of the forecasts, the procedures and techniques of prospecting and exploration, and the geological and economic evaluation of the discovered reserves.

One cannot accept the fact that scientific research institutes as yet rarely include in their plans the study of problems of fundamental geological-exploration prospecting technology changes. The point of the entire activity of geological science must be directed to the intensification in every possible way of the exploration of new reserves of mineral resources. It is necessary to improve the planning of these operations on the basis of integrated programs and concentration of the efforts of scientific-research institutes and design offices on the key problems of improving the work of the sector.

In this regard, the experience of the UkSSR Ministry of Geology which has begun jointly with the Academy of Sciences of the republic the development of the intersectorial programs "Prognoz [Forecast]" and "Poisk [Search]," deserves attention. Their realization will significantly increase the scientific validity and quality of gas and oil geological-exploration operations and forecasting results. The Soyuzgeologorazvedka and Soyuzpromgeofizika associations are purposefully creating and mastering new technical means for prospecting and exploring deposits. This makes it possible to increase labor productivity significantly and to improve the quality of test borings.

One must especially say something about the prospecting strategy in Western Siberia. It must be remembered that here there must be reference not only to the geological development of new areas in this region, but also to drilling to deeper-lying levels of already developed oil and gas bearing regions.

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The decree adopted by the CPSU Central Committee and the USSR Council of Ministers concerning additional measures for the technical re-equipping of enterprises the gas, oil, and geological sectors opens up a wide range of options for mineral prospectors. The main thing is to persistently introduce

the achievements of scientific and technical progress. And here the geologists need the help of machine builders and instrument makers. The staffs of the industries should establish systematic monitoring of the course of fulfilling the goals envisaged by the decree.

Sometimes the geologists work under severe conditions and many of their routes lie in uninhabited, almost inaccessible places. Therefore managers and local party committees must show great concern for the working, living, and relaxation conditions of the mineral prospectors. More living quarters, kindergartens, and day nurseries must be built.

The final year of this 5-year plan is coming to an end. The labor collectives of the sector need to analyze the results of their work rigorously and fundamentally and to define new goals. Communists must set an example of a conscientious attitude to matters. Party organizations are urged to develop socialist competition in the collectives even further, to improve ideological-political work with people, and to generate an atmosphere of creativity, mutual exaction, and discipline. It is important to increase the role and authority of foremen, engineers, technologists, and all who participate in prospecting operations.

The geologists of the country, like the toilers of other sectors of the national economy, are performing a labor watch in honor of the upcoming 275th CPSU Congress. May their contribution to strengthening the raw material base of our economy be even more substantial.

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CSO: 1842/26

## BUREAUCRATIC WASTE OF MINERAL RESOURCES SCORED

Moscow SOTSIALISTICHESKAYA INDUSTRIYA in Russian 11 Oct 85 p 2

[Article by P. Khabibullayev, president of the Academy of Sciences of the Uzbek SSR, Tashkent, under the rubric "Strict Accounting for Resources": A Knot of Interests"]

[Text] In the minds of many, the Angren deposit is a gigantic stock of coal. But the fact is, nature has stored in its depths many kinds of raw materials, from kaolin and limestone to trace metals. But, so far, of these riches only the brown coal is being widely utilized. And the minerals being extracted at the same time are going into dumps where they quickly lose their value. In them, for example, about 37 million tons of kaolin and many other important constituents already have been lost to the national economy. The workers in the ministries and departments often complain about the difficulty of mining raw materials. Yet, here, raw materials are being extracted along with the coal. But no one is rushing to take advantage of them.

In this, the losses, in essence, are twofold. The practice of dumping is not cheap. For instance, expenditures for the extraction and storage of the overburden rock already exceeds two thirds of the cost of the coal commodity production of the Angren strip mine. Under the dumps, vast areas of soil vanish. It would seem that the way out is obvious. Instead of wasting huge efforts and funds on the storage of the incidental raw materials, it would be better, right away, to put it to use. What prevents this? First of all, it is an absence of the coordination of activities.

Seven union ministries participate in the fate of the Angren deposit. But the habit of their workers to live by old concepts and go along well-trodden paths is clearly traced in the example of the kaolin. The attitude of the Ministry of the Coal Industry toward the kaolin is unique; namely, let anyone take it, as much as you wish, at a throw-away price of 45 kopeks per ton. The truth is, that "forgetting" about their own expenditures on dumps, the coal miners decline to waste effort on the preliminary separation of kaolin by grades. But in this case, the principal consumer, the Ministry of Construction Materials, should jump at such cheap and available raw materials. But in fact it seeks in every way to avoid a solution of the problem.



The reasons are well known. For brick and cement production, kaolin does not require enrichment. It is another matter for the production of bathroom and lavatory ceramics, glazed articles, and consumer goods -- one cannot manage without preliminary enrichment here. Meanwhile, at the Angren Ceramic Works, which requires up to 200,000 tons of kaolin per year, enrichment operations have long been obsolete. And the ministry, from the beginning reduced the second section of the enriching factory to an experimental production line. And then, it also disappeared from plans. In justification, a declaration appeared: in the region, they say, there is no demand for it although, the fact is, kaolin is brought into the republic from other parts of the country. Moreover, the shortage of kaolin frequently leads to failure in the assigned production of brick, colored portland cement, and other products.

With reference to the "absence of demand", as a blind, other ministries also cover up, ignoring the problems of another day. Twice, for instance, in the pages of SOTSIALISTICHESKAYA INDUSTRIYA specialists raised the question of the reprocessing of Angren kaolin into alumina suitable for obtaining aluminum. A warning that the traditional raw material, bauxite, is already on the way out and of the need to search for new sources supposedly would be heard by the USSR Ministry of Nonferrous Metallurgy. But the institute of the sector, the VAMI [All-Union Scientific Research and Planning Institute of the Aluminum, Magnesium and Electrode Industry], concluded that with existing technology, the period of time for investment recovery for alumina production will be excessively long. And there the matter stands. The question is, should not the science of the industry be occupied with development of a more effective technology while not waiting for the onset of a critical situation? The leadership of the USSR Ministry of Nonferrous Metallurgy, however, preferred to hold the decision on the problem for the year 2000.

In the opinion of scientists of the USSR Academy of Sciences Institute of Metallurgy, about 300,000 tons of coagulents necessary for purifying drinking and waste water can be inexpensively obtained from the same Angren kaolin. The introduction of this technology at the Almalyk Chemical Plant alone would permit laying up thousands of tons of aluminum hydroxides for aluminum production needs. It is unfortunate that the Ministry of Mineral Fertilizer Production intended to develop an experimental installation at the plant no earlier than 1987. But still, the Ministry of the Chemical Industry displayed great "care" about the prospect. It turned to Union Gosplan with a request to be excluded from among the participants in the work on the comprehensive exploitation of the deposit.

For years on end a correspondence has been conducted between the staffs of the industrial sectors, the union and republic planning organizations and the scientific establishments. Familiarity with it gives birth to the feeling that many workers of the ministries still are not morally prepared for the solution of problems decreed in the April 1985 Plenum of the CPSU Central Committee and at the Committee conference on the question of accelerating scientific and technical progress. In the practice of these industrial sectors, the preservation of resources still has not become the core of technical policy targeted on the future. A striving to solve controversial questions which impede the comprehensive exploitation of raw material by common efforts is absent. Rather, it is the other way around. The

ministries hurry to utilize the miscalculations of associates to legitimize their own sluggishness.

Significant in this plan is the fate of the Angren special coals containing rare metals. At one time, collectives of the union and republic academies made considerable efforts to organize a wasteless production chain. The coal strip was to have supplied special coal to the Angren GRES. Here, it was planned to catch the fly ash formed during burning by means of electric filters and to send it to the Angrenenergotsvetmet

enterprise for the extraction of the metals. As a matter of fact everything is proceeding differently. For many years Angrenenergotsvetmet has been using ash sent from Chita. The transportation costs alone amount to about 300,000 rubles a year. And at the GRES where the special coals are burned together with ordinary coal, millions of rubles annually are thrown to the winds - borne away with the smoke.

Why does it go so? Because the workers of the Ministry of the Coal Industry, the Ministry of Power and Electrification, and the Ministry of Nonferrous Metallurgy prefer not to be guided by State interests but by departmental interests. The strip mining colliery should provide for separate mining and delivery of the special coals which, naturally, has an effect on its indicators. Correspondingly, at the GRES, the special coals must be burned separately. But they have an increased ash content which also tells on the indicators of the production of electrical power. Therefore, the coal miners and the power engineers regard the wasteless technology without enthusiasm. And the Ministry of Nonferrous Metallurgy, seeing their resistance, prefers more reliable partners.

It would seem to be high time for representatives of the three ministries to sit down at the negotiation table so as to, through a revision of prices and specifications, interest all participants of the productive chain. The more so, as there is an imperative necessity in that deliveries of Chita fly ash are steadily diminishing. But the partners are not hurrying. In the present five-year plan the Ministry of the Coal Industry agreed to bring annual deliveries of special coals to the Angren GRES only up to 100,000 tons, but this obligation is only half fulfilled. In its turn, the Ministry of Power and Electrification of the USSR is delaying modernization of the existing station. And at the Novo-Angren GRES being built alongside, the catching of fly ash, in general, is not provided for. In sum, of the proven reserves of a valuable raw material, more than 40 percent already has flown out the chimney. Sluggishness is turned into wastefulness.

Unfortunately, we became accustomed to look upon the effect of the onesided exploitation of the deposit as an unavoidable evil. Today dumps occupy about 70 hectares of valuable land within the borders of Angren where more than 5 million tons of ash being created at the Angren GRES have been piled up. Every year these "reserves" are increased by 350,000 tons. And the Navoi Cement Works, because of an interruption of ash deliveries in the past year, underproduced 120,000 tons of cement. Meanwhile the utilization of ash in cement production permits a saving of up to 15 percent of standard fuel and increases the productivity of the equipment by 20 percent. But to

carry the ash out of Angren, as with the raw material being mined along with the coal, is almost impossible - the railroad spur is weak . . . Long ago the question of its reconstruction became urgent. All appeals to the Ministry of Railways, however, have had no results despite the conclusion of a working commission of USSR Gosplan.

The practice of the past years has given birth around the Angren deposit to a complex tangle of problems the untangling of which can be done only on an intersectorial basis. Specialists of the union Gosplan, the GKNT [State Committee of the Council of Ministers on Science and Technology], and workers of the Party and economic bodies of the republic, share this opinion. With their support, an appropriate program was included in the all-union program "Providing for the Comprehensive Utilization of the Principal Kinds of Mineral Resources". It seems to us that in the future a territorial production complex with a unified extradepartmental management capable of providing for the efficient utilization of all the natural resources should be formed on the basis of the Angren deposit.

For this, it is necessary, right now, to work up in detail the structure of the complex the network of production, transportation, and economic relations and to organize the development of progressive technologies and equipment. Leading the work in this direction is the Tashkent Scientific Center which was created within the organization of the republic Academy of Sciences on the initiative of the Party obkom. But the scale of the problem is such that even in the general formulation it is beyond its powers. It seems that a temporary scientific production collective should be created on the basis of the scientific center to act as the client and coordinator of all the investigations and developments. The complex Angren deposit needs a comprehensive solution of the problem.

9136  
CSO: 1842/51

# CALCULATION OF DISPLACEMENT AND DEFORMATION OF THE EARTH'S SURFACE AT THE NIKOPOL MANGANESE DEPOSIT

Dnepropetrovsk METALLURGICHESKAYA I GORNORUDNAYA PROMYSHLENNOST in Russian  
No 3, Jul-Sep 85 pp 56-57

GAVRYUK, G. F., Dnepropetrovsk Mining Institute

[Abstract] Based on instrumental observations at four observation stations over a five-year period, a method was developed to calculate expected displacement and deformation of the surface of the earth in response to underground manganese mining. The calculation was based on the idea of typical curves. A figure presents mean values of displacement and deformation distribution functions obtained from several determinations. It is found that mining by the longwall method causes greater deformation of the surface than short runs, which has a negative influence on undermined structures and natural objects. References 2: both Russian.  
[42-6508/12955]

UDC (622.7+669.63):622.345

# SIGNIFICANT RESERVES OF METALS MADE AVAILABLE BY MORE COMPLETE EXTRACTION OF TIN-POLYMETAL ORES

Moscow TSVETNYYE METALLY in Russian No 9, Sep 85 pp 88-91

GULYAIKHIN, Ye. V., KOTLYAROV, V. G. and LEBEDEV, I. S.

[Abstract] Extraction of tin and scarce companion metals from concentrates at the Solnechnyy Mining and Ore Dressing Combine by multistage gravity-flotation processes involving selective flotation of sulfides, final concentration of crude concentrates, and extraction of metals from the slurry. The excess losses using this conventional method does not exceed 5-6% tin, 22-23% lead, 35-36% zinc, 22-23% bismuth entering into copper concentrate and approximately 30% tungsten entering tin concentrate, much of these metals getting lost with the removal of arsenic. According to several studies, particularly that were made by V. A. Khrapenko and that were made by V. D. Pomazov, polygradiental or electrical separation of byproducts during refinement of crude concentrate and their subsequent metallurgical processing can substantially increase the yield of the extractable metals. Five methods of metallurgical processing have already been proposed: 1) cyclone-electro-thermal smelting; 2) vacuum-thermal pyroselection; 3) chloridation-sulfurization roasting; 4) two-state chloridation roasting after preliminary de-arsenation and desulfuration; 5) fuming of low-copper byproducts either after arsenic removal by roasting of the raw material or before arsenic removal by trapping in the gaseous phase. All these methods are viable, but require different equipment and differ in particular effectiveness relative to any given

extractable metal. The last method has already been advanced to an industrial scale. Studies made by Yu. S. Arzamastsev indicate that its overall effectiveness can be very high, but the other methods ought to be also further elaborated so that the most efficient and economical variant can be selected and appropriate equipment be built. The industrial demand for tin, tungsten, and other metals including also precious ones such as silver will then be more easily covered without increasing the depletion of ore deposits. [34-2415/12955]

UDC 622.765.063.01

#### USE OF POTENTIOMETRIC METHODS FOR DETERMINING FLOTABILITY OF ORES

Moscow TSVETNYYE METALLY in Russian No 9, Sep 85 pp 92-94

ILLYUVIYEVA, G. V., GORSHEYN, A. Ye. and BARON, N. YU.

[Abstract] The usefulness of potentiometric methods in preparation of sulfide ores for flotation is demonstrated on pyrrhotite-pentlandite-chalcopyrite ore containing 80% sulfides with approximately equal 3% Cu and 3% Ni. Flotation of such an ore is preceded by aeration, which improves the selectivity of the process. The oxidation-reduction potential of a smooth platinum electrode immersed in ore pulp can be measured, relative to a standard AgCl electrode, using an R-363 d.c. potentiometer with an automatic recording instrument. The potential rises during aeration till it reaches a constant level, which differs for different minerals and indicates their readiness for flotation. Addition of  $\text{Na}_2\text{SO}_3$  flux or butyl aerofloat does not affect the potentiometer readings throughout the aeration process, inasmuch as they do not inhibit the oxidation, but addition of  $\text{Na}_2\text{SO}_3$  for improvement of the flotation process or admission of undesirable hydrogen after aeration lower that potential drastically. These trends correlate closely with standard indicators of the copper flotation process. The reducing effect of  $\text{Na}_2\text{SO}_3$  and  $\text{H}_2$ , each in a different way, is explained by the presence of  $\text{SO}_4^{--}$  and  $\text{S}_2\text{O}_3^{--}$  ions instead of  $\text{SO}_3^{--}$  ions in the solution. In a special separate experiment, the effect of aeration on the properties of individual sulfides in an ore and the dependence of these properties on the length of aeration time were determined potentiometrically with electrodes made of the respective sulfides in 0.01 M  $\text{Na}_2\text{SO}_4$  solution. The results confirm that depression of FeS and NiS for copper flotation requires removal of elementary sulfur from the surface of those two sulfides. References 9: all Russian. [34-2415/12955]

FIFTEENTH INTERNATIONAL CONGRESS ON ENRICHMENT OF USEFUL MINERALS: ENRICHMENT OF COMPLEX AND CHURLISH ORES FOR MOST NEARLY FULL UTILIZATION OF RAW MATERIAL

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[Abstract] The fifteenth International Congress on Enrichment of Useful Minerals was held on 2-9 June 1985 in Cannes (France). A Soviet delegation participated which represented the USSR Ministries of Ferrous Metallurgy and Nonferrous Metallurgy, Fertilizers, Geology, Heavy and Transport Machine Building, and Higher and Secondary Specialized Education as well as the USSR Academy of Sciences, the State Committee for Utilization of Atomic Energy, and the KaSSR Council of Ministers. Enrichment of complex and churlish ores for the most complete utilization of raw material was covered in 147 reports, including 73 presented at plenary as well as special sessions. They dealt with progress in scientific research and experimental engineering activities in various countries, namely: combined use of magnetic and centrifugal forces for separating particles of minerals with different densities, magnetic partitioning of Cu-Pb concentrate, partitioning of Cu-Pb-Zn concentrate by preliminary lixiviation of zinc with sulfuric acid and subsequent flotation of copper sulfides, selective coating of nonmagnetic minerals with ferrous particles having similar flotation characteristics, new fluxes and fluxing processes for flotation of sulfide and fluorite ores as well as for selective flotation of slurry, selective nickel extraction from Cu-Ni concentrate by electrical lixiviation in  $H_2SO_4$  solution, a superconducting magnetic separator, a classifier consisting of a hydraulic cyclone and cylindrical sieve, a flotation machine with 60 m<sup>3</sup> large chamber, a novel design of pneumatic flotation machine with tank for better aeration, hermetic flotation machines for operation in an atmosphere of inert gases such as nitrogen, conical crushers with automatic regulation, a sifter with echelon grating for separating sticky clay ores, and other developments. The main trends in this area worldwide appear to be development of combined enrichment-hydro-metallurgical and purely hydrometallurgical processing of complex raw material, development of technical mineralogy as a science, and mathematical modeling of technological processes with the software necessary for their automatic control in ore dressing plants. Items of particular interest to Soviet specialists should be semiautomatic crushing of zinc ore with steel balls constituting up to 20% of the total volume and fully automatic crushing of zinc ore with regulation of crusher speed depending on the hardness and the grain size of fed ore, both methods having been developed in France and introduced in the St. Salvey plant along with the use of rubber or polyurethane pulp troughs, sump pumps speed control through V-belt varidrive, and industrial television for monitoring the pulp distributors.

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